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Some Misapplications of the Linnaean Names Applied to American Snakes

By L. M. Klauber

IT IS the purpose of this paper to point out that several Linnaean names are currently applied to the wrong species of American snakes. Some of these misapplications are the result of changes instituted by herpetologists within the last 50 years, while others are the outgrowth of decisions made by naturalists immediately following the era in which Linnaeus worked—decisions that gradually came to acquire the authority of established usage, although originally premised on inadequate data.

The Linnaean Methods

The snake descriptions contained in the tenth edition of Linnaeus' *Systema Naturae*—the foundation upon which all zoological nomenclature is based—are usually brief and lack the diagnostic definiteness of modern descriptions. It is this vagueness that has led to so many uncertainties in the allocation of Linnaean names. But the fact seems sometimes forgotten that, with respect to the great majority of the snakes he described, Linnaeus had before him actual type specimens. Were these types in existence today, any nomenclatorial argument or uncertainty could be settled immediately by recourse to them, for a type takes precedence over any description. This has indeed been done in the case of many snake species, the types of which still remain in the Swedish museums where Linnaeus worked (Lönnberg, 1896; Andersson, 1899, 1900). But the eventual disposition of the types of certain snakes found in the United States, of which specimens were sent to Linnaeus by Peter Kalm and Dr. Alexander Garden, is unknown, and therefore dependence must be placed on the descriptions.

In order to discuss these nomenclatorial problems, it is necessary to recall the Linnaean methods. Nearly all of the snake descriptions, whether in the tenth or twelfth edition of the *Systema Naturae,* follow a fairly regular pattern, with the following order of entries:

1. A species number. This usually equals the sum of the ventrals and subcaudals of the type, but may be changed by adding or subtracting one or two digits if the sum results in a duplication of the number assigned to some other snake. Gaps between numbers are not avoided. The sex of the type, if known, is indicated by an appropriate sign immediately below the species number.

2. The species name assigned to the animal, sometimes with the initial letter capitalized, but more often lower case.

3. The ventral and subcaudal scale counts of the type specimen.[1] This is the most important part of the description, since it is the only part derived exclusively from the type specimen and hence purely objective. The studies of Lönnberg and Andersson have shown that Linnaeus' scale counts were usually accurate. In the twelfth edition these counts are followed by the capitalized initial of the genus.

1 What reams of controversy would have been avoided had Linnaeus only included the scale rows at mid-body.

4. A primary reference,[2] serving both as a record of the museum containing the type specimen, and an indication of where an expanded description of the type, written by Linnaeus or one of his students, may be found. For example, the primary reference under *Crotalus dryinus* is "Amoen. acad. I. p. 297." From this reference to the *Amoenitates Academicae* (second or collected edition, vol. 1, no. 11), we learn that the type of *dryinus* was preserved in the Museum Principis (Donatio Adolphi Friderici, per Lönnberg, 1896: 4, 12) and that this and other snake specimens in the museum were described in a dissertation by Linnaeus that was defended by L. Balk. This description in the *Amoenitates* is much more detailed than that carried forward into the *Systema Naturae* by Linnaeus, and one should naturally expect that it would be of material assistance in defining a species. But unfortunately these enlarged descriptions are often not restricted to the type specimen; on the contrary, generalities from other citations (which may be termed tertiary references) are introduced, and there is difficulty in segregating the statements that were based on an examination of the type specimen from those culled from the tertiary references. As to the latter, they are usually highly confusing, since both overlapping and composite effects are introduced. For example, both primary references under Linnaeus' rattlesnakes *C. dryinus* and *C. durissus* introduce a tertiary reference to Nieremberg's *Historia Naturae,* 1635, page 268, plate 268.[3] The point of this is that Linnaeus' two species could not both be Nieremberg's (or rather Hernandez') rattlesnake, which is the creature we know today as *Crotalus durissus.* This is an example of overlapping. And when one tertiary reference under *durissus* describes a rattlesnake from Virginia, while another describes one from Brazil, we see how they result in confusion through the introduction of composites. I think no further proof is needed that the tertiary references often tend to confuse, rather than clarify, these problems of allocation.

Often the primary reference is replaced with the name of a museum or collector. In such cases we are dealing with types not previously described by Linnaeus or his students. Types carrying the name of a collector are understood to refer to specimens in Linnaeus' own personal collection. It is with specimens falling in this category that the present article deals.

5. Following the primary references in the *Systema Naturae* itself, one or more secondary references are usually given. They call attention to the works of prior authors, who, Linnaeus thought, had described the same snake he then had in hand. While sometimes helpful, they are often confusing, for they may refer to species obviously different from that Linnaeus was studying, and sometimes—if there are two or more—they may refer to several different snakes.

6. Following the references, the habitat is given, usually in such broad terms as to be quite useless as an aid to identification. Often only the continent is indicated, and even this is frequently incorrect, as has been shown by Lönnberg and Andersson. The museum curators or the collectors were largely to blame for these inaccuracies of location.

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[2] For a discussion of primary and other references see Hemming, 1947: 596.
[3] Copied without credit from Hernandez, *Quatro Libros de la Naturaleza,* 1615, or a subsequent edition of the same work.

7. Finally there is a brief description in terms of form, color, pattern, or other morphological details, together with occasional field notes. Except for the scale counts, mentioned under 3, these descriptions comprise the most important part of the entire entry, for they are largely based on the type specimens themselves. Unfortunately, many of them are too brief or vague to be distinctive.

It is essential to remember that the early workers in herpetology who followed Linnaeus, such as Daubenton, Bonnaterre, Laurenti, Lacépède, Latreille, Daudin, and Shaw, did not have access to his types, nor could they know that Linnaeus' work would one day take precedence, with respect to nomenclature, over all others of those days. In the successive improvements in ophiological classification and co-ordination that they undertook, they did attempt to connect the Linnaean descriptions with such specimens as they themselves had, and they did try to clarify the confusion of the names assigned by successive authors to what each thought was the same snake. But many of the descriptions they were attempting to allocate were in themselves composite, or contained composite references, so it is no wonder that years elapsed before there began to be a crystalization of these applications of names and a general agreement among herpetologists as to what snake was meant by such a designation as *Boa alba* Linnaeus, 1758. These crystalizations were to some extent the outgrowth of custom rather than a direct application of whatever data were contained in the original Linnaean description.

The question whether the application of a Linnaean name should be changed at this late date depends on the certainty with which it can be proved that the name is currently misapplied. A name of long standing should not be discredited if we are merely to exchange one uncertainty for another. As I have discussed elsewhere (Klauber, 1941: 81), the Linnaean rattlesnake names are probably misapplied, but they cannot be reassigned with certainty, so the temporary confusion that would follow their reshuffling cannot be justified. An example of a slightly different kind is the snake known as *Natrix sipedon* (Linnaeus), 1758. His description is so brief that it might fit any of several snakes, but it is equally true that it does fit the common water snake, so we cannot prove that the name is misapplied. But where it is possible to prove, almost as certainly as if the type were before us, that the Linnaean name has been misapplied, then a change is justified.

It will naturally be inquired why, after so long a time, a resurvey of these applications of Linnaean names should be made, for surely all pertinent information has long been available to herpetologists. But, as a matter of fact, this is not true, because the recent intensive work that has been done on many genera has increased our knowledge of the ranges of variation in ventral and subcaudal scale counts. Had such data been available to the early successors of Linnaeus, they would have been guided more by his scale counts in their decisions and less by his bibliographical references, which we now know to be conflicting.

Linnaean Collectors in the United States

All of the Linnaean species of snakes occurring in the United States, with one exception,[4] were derived from two collectors, Peter Kalm, the Finnish-

[4] *Crotalus horridus*, the name being doubtfully applied to the timber rattlesnake.

Swedish naturalist, and Dr. Alexander Garden, of South Carolina. Since their collections are of such importance to the nomenclature of our snakes, and it has not always been recognized by herpetologists that actual type specimens had been sent to Linnaeus by Kalm and Garden, it will be advisable to discuss these collectors and their relationship with him.

Pehr (or Peter) Kalm was first a student of Linnaeus and later a professor at the University of Åbo. When the Swedish government decided to send someone to America to collect plants and seeds that might be grown successfully in Sweden and thus improve its agricultural productivity, Kalm was chosen upon the recommendation of Linnaeus. He remained in the New World from September, 1748, until February, 1751, traveling extensively in New York, New Jersey, Pennsylvania, and Ontario. He published the results of his observations in a 3-volume work *En Resa til Norra America* (Stockholm, 1753–1761). Subsequently this went through many editions and translations, the most recent and complete being Adolph B. Benson's *Peter Kalm's Travels in North America* (New York, 2 volumes, 1937).

Although, to fulfill his mission, Kalm concentrated on botanical material, he was interested in all branches of natural history. Among the animals that eventually reached Linnaeus there were at least 5 snakes that became the type specimens of species described by him in the tenth edition of the *Systema Naturae*. The present status of these species is shown in Table I.

TABLE I

KALM SPECIMENS

Linnaean Name	Page Ed. 10 S. N.	Present Name Ed. 5 Stejneger & Barbour Check List	Page Ed. 5 S. & B.
Coluber leberis	216	Not valid	
Coluber constrictor	216	**Coluber c. constrictor*	128
Coluber sipedon	219	*Natrix s. sipedon*	161
Coluber sirtalis	222	*Thamnophis s. sirtalis*	172
Coluber ovivorus	223	Not valid	

* Genotype.

The other collector whose activities were important in the taxonomic development of American zoology was Dr. Alexander Garden, of Charleston, South Carolina. In the early 1760's, he sent to Linnaeus, in Sweden, several lots of fish and reptiles that he collected in "Carolina." The tenth or basic edition of the *Systema Naturae* had already been published in 1758, but Linnaeus took advantage of the Garden material to add a number of new species in the twelfth edition before its appearance in 1766.

First, a few words about Dr. Garden himself, of whom every girl carries a memento when she wears a gardenia to a dance. According to Goode (1901: 388):

> One of the most eminent of our colonial naturalists was Doctor Alexander Garden, born in Scotland about 1728 [d. 1791]. He emigrated to America about 1750, and prac-

ticed medicine in Charleston, South Carolina, until after the close of the Revolutionary War, when he returned to England, and became very prominent in scientific and literary circles, and vice-president of the Royal Society in 1783. He was an excellent botanist, but did his best work upon fishes and reptiles. He sent large collections of fishes to Linnaeus, which were so well prepared that when I examined the fishes in the Linnaean collection in London, in 1883, I found nearly every specimen referred to by him in his letters in excellent condition, though few collected by others were identifiable.

Many of the letters from Dr. Garden to Linnaeus and others were published by Sir James Edward Smith in his *A Selection of the Correspondence of Linnaeus and Other Naturalists* (London, 2 volumes, 1821), the Garden material occupying pages 284 to 605 of volume 1. Several excerpts mention reptiles. On January 13, 1760, Garden wrote to his friend John Ellis (p. 469):

> I have a few snakes, etc., for him [Linnaeus]. I never before looked to our fishes attentively, but I am struck with astonishment at Catesby's blunders. Sometimes he forgets whole fins, etc. In a word, there is nothing can possibly recommend him but the specious beauty of the colouring of the plates.

A year later he wrote again to Ellis (p. 502):

> I have likewise sent a box of snakes of many different kinds; I believe many more than ever went from America before at one time, and a much greater variety: they are all carefully preserved.

In a letter to Linnaeus dated April 12, 1761, Garden mentions sending specimens including "*Amphibia* of the orders *Nantes* and *Reptilia*, natives of this country, particularly some Tortoises and Lizards" (p. 305). He also mentions sending descriptions of reptiles to Linnaeus (p. 308); unfortunately, Smith did not consider it worth-while to print these descriptions. In a letter to Linnaeus dated June 2, 1763, Garden tells of having received Linnaeus' letter of October 5, 1761, and is pleased to learn that the specimens of "fishes, insects, serpents, etc., . . . were agreeable to you" (p. 309).

Much of the material with which Linnaeus worked belonged to various scientific institutions in Sweeden. Such type specimens of reptiles as still exist in these collections have been studied by competent modern herpetologists with the idea of verifying the present applications of the Linnaean names; reports of these determinations have been published by Lönnberg (1896) and Andersson (1899; 1900). But the Garden material seems to fall in a separate category, evidently having been considered a part of Linnaeus' personal property; and, as such, the fish were bought by Sir James Edward Smith with Linnaeus' library when he purchased it for subsequent presentation to the Linnean Society of London. There the fish collected by Garden have remained to this day; they have been examined and reported on by Goode and Bean (1885: 193) and Günther (1899: 15). But of the reptiles I have found records of only three specimens, the types of the species now known as *Cnemidophorus sexlineatus, Elaphe guttata,* and *Ophisaurus ventralis.*[5] I had hoped Smith might have acquired the reptiles with the fishes and presented them to the Society. But Mr. S. Savage, Librarian and Assistant Secretary, advised me, under date of July 16, 1947:

[5] Found by Lönnberg (1896: 17, 36, 38) in two Swedish collections to which they did not originally belong.

I would confirm that there are no specimens of Amphibia[6] in the Linnaean Collections at this Society today; nor is there any evidence that Sir James Edward Smith received such specimens.

Jackson (1913: 8) states that the Amphibia belonged to the University of Uppsala, but he is not referring to the Kalm or Garden material.

In the twelfth edition of the *Systema,* Linnaeus indicated the Garden specimens by the designation "D. Garden" or simply "Garden," usually entered in the first line after the scale counts. The present status of the nomenclature derived from the Garden material is set forth in Table II.

Here we have a total of 16 species named by Linnaeus from types sent him by Dr. Garden[7]; of these, 13 are recognized as valid today; one, however, only as a subspecies, this being *Natrix sipedon fasciata* (Linnaeus), 1766, a subspecies of *Natrix sipedon* (Linnaeus), 1758. Six of the Garden species are genotypes.

TABLE II

GARDEN SPECIMENS

Linnaean Name	Page Ed. 12 S. N.	Page Ed. 13 S. N.	Present Name Ed. 5 Stejneger & Barbour Check List	Page Ed. 5 S. & B.
Lacerta sexlineata	364	1074	*Cnemidophorus sexlineatus*	105
Lacerta quinquelineata	366	1075	Not valid	
Crotalus miliarius	372	1080	**Sistrurus m. miliarius*	183
Boa contortrix	373	1082	*Heterodon c. contortrix*	124
Coluber simus	375	1086	*Heterodon simus*	125
Coluber striatulus	375	1087	**Haldea striatula*	165
Coluber punctatus	376	1089	**Diadophis p. punctatus*	122
Coluber fasciatus	378	1094	*Natrix sipedon fasciata*	161
Coluber doliatus	379	1096	Not valid	
Coluber ordinatus	379	1097	Not valid	
Coluber fulvius	381	1104	*Micrurus f. fulvius*	175
Coluber getulus	382	1106	*Lampropeltis g. getulus*	149
Coluber saurita	385	1109	**Thamnophis s. sauritus*	171
Coluber guttatus	385	1110	*Elaphe guttata*	137
Coluber aestivus	387	1114	**Opheodrys aestivus*	126
Anguis ventralis	391	1122	**Ophisaurus ventralis*	96

* Genotype.

I have stated that, with the possible exception of *Crotalus horridus,* the Kalm and Garden material comprised the only snakes, from what is now the United States, that were available to Linneaus, all other material in the Swedish museums to which he had access being from other parts of the world. This explains their fundamental importance in the history and nomenclature of our ophidian fauna. It is fortunate that we know that Kalm traveled in New Jersey, Pennsylvania, New York, and southern Ontario, while Garden collected in the vicinity of Charleston, South Carolina. It is obvious how greatly this simplifies the applications of names based on inadequate data, for the multiplicity of forms restricted to the west and far west need not be considered.

[6] This term as used by Linnaeus, included reptiles.

[7] Gmelin in the thirteenth edition (1789: 1097) assigned another Garden specimen, not previously mentioned by Linnaeus, to the species *Coluber* (=*Cemophora*) *coccinea* Blumenbach, 1788.

It is my opinion that changes are required in the application of six Linnaean specific names. I shall discuss in detail how the misapplications have come about.

Boa contortrix LINNAEUS, 1766

For 150 years prior to 1917 the copperhead had been called *Agkistrodon* (or *Ancistrodon*) *contortrix*, the name being founded on Linnaeus' *Boa contortrix* of the twelfth edition of the *Systema Naturae*. With the publication of the first edition of their *Check List of North American Amphibians and Reptiles*, Stejneger and Barbour changed this assignment of the name. They stated that, in describing *Boa contortrix*, Linnaeus had in mind the hog-nose snake, which therefore should be called *Heterdon contortrix* (Linnaeus), 1766, and that the copperhead must take the next available name, this being *Agkistrodon mokasen* Beauvois, 1799.[8] But there seems to me to be a defect in the Stejneger and Barbour reasoning, thus requiring a return to the older nomenclature. The matter is somewhat involved, necessitating certain explanatory details.

The Stejneger and Barbour decision was premised on the following argument (1917: 76, footnote): Linnaeus' description of *Coluber constrictor* in the tenth edition of the *Systema Naturae* (p. 216) was composite, being based in part on the black snake, in part on the hog-nose. In the twelfth edition he recognized and corrected his mistake, assigning the name *constrictor* to the black snake, and giving the name *Boa contortrix* to the other member of the formerly confused pair. Stejneger and Barbour decided that this other member was the hog-nose because of the scale counts (130 ventrals, and 40 subcaudals) accompanying the 1758 (tenth edition) description, the words *"Maxillae apex simus triqueter,"* a part of the composite description, and the further fact that in the corrected, twelfth edition (1766: 373), Linnaeus introduced a reference to Catesby's description of the hog-nose.

What Stejneger and Barbour failed to take into account is that the 1766 description of *Boa contortrix* is more than a mere correction of the confusion existing in 1758; it is the description of a type specimen newly acquired subsequent to 1758; and whatever may have been the second member of the confused pair of 1758, there is no doubt that the newly acquired type specimen could only be a copperhead, and it is so described.

I do not say that in 1766 Linnaeus had in his mind a clear distinction between the copperhead and the hog-nose. In fact, he continues to show confusion in two ways: first, by citing his own *C. constrictor*, 1758, as a partial synonym of *B. contortrix*, 1766; and, also, by his secondary reference to Catesby's hog-nose. It may be well to dispose of these two points before proceeding to a discussion of Linnaeus' new type. The reference to *C. constrictor*, 1758, under *B. contortrix*, 1766, is of no nomenclatorial importance in assigning the proper name to the copperhead. Linnaeus, as the first reviser of his own work, had the right to assign the name *constrictor* to either of the confused pair of 1758; he assigned it to the black snake, thus making it unavailable for either the copperhead or hog-nose. And as far as the reference to Catesby is concerned, this is an unfortunate error, but a quite character-

8 Subsequently Gloyd and Conant (1943: 149) showed that *mokasen* Beauvois was *a nomen nudum*, and hence they adopted, for the copperhead, the next available name—*mokeson* Daudin, 1803.

istic one. Linnaeus often cited references that were in themselves composite, or that described creatures quite different from those he was himself describing.

The actual type of Linnaeus' *Boa contortrix* of the twelfth edition, 1766, was not a part of the composite *Coluber constrictor* of the tenth edition, 1758, for it was a Garden specimen, not received until after the publication of that edition. The scale counts are given as 150 ventrals, and 40 subcaudals; these are well within the range of the copperhead, but the ventrals are high and the subcaudals are low for a hog-nose. The description may be translated thus: "Habitat Carolina. The head is broad and strongly convex. It has venom glands, but fangs are not evident. The dorsal color is gray, with dark blotches, and with dark spots along the sides. The tail is 1/3 [9] the length over-all." This, like most of Linnaeus' descriptions, is too brief to be conclusive, and were this all, we might still hesitate between the hog-nose and the copperhead, even though Linnaeus has now dropped the "triangular snout" of the composite description of *constrictor*. But the most conclusive evidence of all is that Linnaeus placed his *contortrix* in the genus *Boa* rather than *Coluber;* for Linnaeus separated these two genera on the basis of their subcaudal scales—*Boa,* undivided; *Coluber* divided—and here the description fits only the copperhead and not the hog-nose.[10] Upon this important generic criterion Linnaeus would have made no error. It may be noted that he did describe a hog-nose snake, *simus,* placing it, correctly, in his genus *Coluber.* Besides the copperhead, only one other snake from Carolina could fall in Linnaeus' genus *Boa*; this is the water moccasin. But the ventral scale counts of the Garden type are too high for that snake. Thus we reach the conclusion that the type specimen of *Boa contortrix* could only have been a copperhead, which, therefore, should be known as *Agkistrodon contortrix* (Linnaeus), 1766; or, if one wishes to follow Boulenger, Malcolm Smith, and others, *Ancistrodon contortrix.* The following subspecies should be recognized:

A. c. contortrix (Linnaeus), 1766
A. c. mokeson (Daudin), 1803
A. c. laticinctus Gloyd and Conant, 1934
A. c. pictigaster Gloyd and Conant, 1943

Since the type of *contortrix* was a Garden specimen from Carolina, the southern copperhead becomes the type subspecies, and *mokeson,* with a type locality near Philadelphia, the northern subspecies.

The allocation of the name *contortrix* to the copperhead also necessitates a return to older usages in assigning names to the common hog-nose snakes. These should be known as:

Heterodon platyrhinos platyrhinos (Latreille), 1801
H. p. browni Stejneger, 1903

Coluber sirtalis Linnaeus, 1758

It is difficult to see how Linnaeus' *Coluber sirtalis* ever became attached to the common garter snake, for the subcaudal scale counts of the type do not

[9] This tail ratio is too high for either copperhead or hog-nose. Gray (1789: 26, f.n.) thinks it in error. He also believes the snake to be venomous (f.n. page 24).

[10] It is not unusual for copperheads to have as many as 1/8 of the terminal subcaudals divided, but in the hog-nose all are divided.

fit that snake. Linnaeus gives the number as 114; the common garter snake rarely, if ever, exceeds 95 in any part of the range of its subspecies, and seldom exceeds 85 in the area where the type was collected. But both scale counts and description fit the ribbon snake.

The early European herpetologists [11] seem merely to have repeated Linnaeus' description with such additions as they could imagine or deduce from the remarks of travelers. There seem to have been no additional specimens available to them. Possibly the first author, well acquainted with American snakes, who attached the name to the common garter snake, was Harlan (1827: 352; 1835: 116). He gives the scale counts of a specimen available to him as 150 ventrals and 60 subcaudals, clearly not the snake described by Linnaeus. He evidently recognized that he was making something of a departure, for he goes on to say that the snake had been "hitherto not accurately described." Holbrook (4, 1840: 91; 4, 1842: 41) realized the doubtful propriety of applying the name to the common garter snake, but felt that if Linnaeus had had the ribbon snake in mind he would not, 8 years later in the twelfth edition, have described the southern ribbon snake as a separate species, *Coluber saurita*. But one snake came from Canada and the other from Carolina; and, when one recalls the great pattern variations occurring in *Thamnophis*, it is not surprising that the two ribbon-snake specimens were described as different species. One might argue with equal force that if Linnaeus had had the common garter snake before him when he described *Coluber sirtalis* in 1758, he would not have described another common garter snake in the Garden Carolina collection as *C. ordinatus* in 1766. At any rate, despite the fact that Harlan made a radical departure, and one somewhat questioned by Holbrook, in applying the name *sirtalis* to the common garter snake, the mistaken allocation has been followed to the present day.

Linnaeus' pattern description of *sirtalis* fits either the garter snake or ribbon snake, but his scale counts are applicable only to the ribbon snake. I think the conclusion inevitable that the name must be applied to the latter, the following subspecies being recognized:

Thamnophis sirtalis sirtalis (Linnaeus), 1758
T. s. proximus (Say), 1823
T. s. sackenii (Kennicott), 1859
T. s. chalceus (Cope), 1860

It is probable that Linnaeus' type specimen of *Coluber saurita*, 1766, came from the immediate vicinity of Charleston, South Carolina, which is near the line of intergradation between the northern and southern ribbon snakes. Further study of the snakes of that vicinity must be made to determine whether the name *sauritus* should replace the later *sackenii* as the name of the southern subspecies. I assume not, since *sauritus* has hitherto been considered applicable to the northern subspecies, and must now be replaced by the earlier name *sirtalis*.

With *sirtalis* no longer available for the common garter snake, the next applicable name appears to be *Coluber ordinatus* Linnaeus, 1766, described from another of the snakes in the Garden collection, with the type locality "Carolina." The description leaves much to be desired in definiteness but

11 Daubenton (1784: 684), Lacépède (2, 1789: 311), Bonnaterre (1790: 62), Latreille (4, 1801: 69), Daudin (7, 1802: 146), Shaw (2, 1802: 535), Merrem (1820: 132).

there are no items, scale counts or otherwise, that do not fit the common garter snake. Unfortunately, longitudinal stripes are not mentioned, but, as Ruthven (1908: 182) has pointed out (he was arguing against considering *ordinatus* as a subspecies separate from *sirtalis*), snakes with and without dorsal stripes may be found in the same brood. Practically all herpetologists, both early and recent, have accepted *ordinatus* as a garter snake, either a synonym of *sirtalis* (as the name was previously applied) or as a valid species or subspecies. While I am skeptical of Linnaeus' secondary references, it may be noted that the two cited in the description of *ordinatus* (Catesby, 2, 1731–43: plate 53; and Seba, 2, 1735: plate 20, fig. 2) show snakes with vertebral stripes, although only Catesby's was a garter snake.[12] Holbrook (4, 1840: 95; 4, 1842: 47) says that snakes with longitudinal stripes are unusual in the southern states; however, it is to be remembered that he considered *sirtalis* (in its older sense) a separate species from *ordinatus*, and tended to assign striped snakes to *sirtalis*.

In view of the confirmatory indications and the almost universal acceptance of Linnaeus' *Coluber ordinatus* as a garter snake, I think the common garter snake should be assigned this name, with the following subspecies recognized:

Thamnophis ordinatus ordinatus (Linnaeus), 1766
T. o. parietalis (Say), 1823
T. o. pickeringii (Baird and Girard), 1853
T. o. concinnus (Hallowell), 1852
T. o. tetrataenia (Yarrow), 1875
T. o. infernalis (Blainville), 1835

Coluber doliatus LINNAEUS, 1766

Until 1917, *Coluber doliatus* Linnaeus, 1766, had been widely used as the specific name of the milk-snake group of king snakes. With the appearance of the first edition of the Stejneger and Barbour check list this name was dropped. Stejneger (1918: 99) explained the change by stating that Linnaeus' snake was unidentifiable, although probably identical with *Cemophora coccinea* of Blumenbach. Blanchard, in his monograph of the king snakes (1921: 207), followed this reasoning.

But it seems to me that the description fits only the milk snake and permits no misunderstanding, and that the milk-snake name in use for more than 100 years should be reinstated. Of all the snakes found in the Carolinas, only the milk snake and the scarlet snake (*Cemophora*) have both rings and scale counts that might satisfy Linnaeus' count of 164 ventrals and 43 subcaudals. But Linnaeus speaks of the paired black rings as not quite surrounding the body on the belly and this could be applicable only to the milk snake, for *Cemophora coccinea* is clear below. It is also to be remembered that in 1787 Gmelin assigned one Garden specimen to Blumenbach's *coccinea;* had this been similar to Linnaeus' *doliatus* (which Gmelin retained as valid) he would have combined them. Blumenbach mentions the fact that his *coccinea* has a white ventrum.

It may be of interest to note that Holbrook (3, 1842: 106), who was

12 The Seba figure has a characteristic checkered pattern that makes it look like a garter snake, although it is stated to be a Brazilian snake.

certainly a thorough student of the herpetology of the Carolinas, reached the same conclusion, considering Linnaeus' *doliatus* a milk snake rather than a scarlet snake.

Until recently one of the uncertainties in disposing of *doliatus,* even assuming it to belong to the genus *Lampropeltis,* was to decide whether it should be assigned to the *triangulum* or *elapsoides* group. But Conant (1943: 3) has shown that *triangulum* and *elapsoides* are conspecific, so that an uncertainty is no longer involved here.

I am therefore of the opinion that *Coluber doliatus* Linnaeus, 1766, should be revived as the specific name of the milk snake, the following subspecies of *Lampropeltis doliata* being recognized:

L. d. doliata (Linnaeus), 1766
L. d. temporalis (Cope), 1893
L. d. triangulum (Lacépède), 1788
L. d. syspila (Cope), 1888
L. d. amaura Cope, 1860
L. d. gentilis (Baird and Girard), 1853
L. d. annulata Kennicott, 1860
L. d. polyzona Cope, 1860
L. d. arcifera (Werner), 1903
L. d. nelsoni Blanchard, 1920
L. d. blanchardi Stuart, 1935
L. d. oligozona (Bocourt), 1886
L. d. schmidti Stuart, 1935
L. d. abnorma (Bocourt), 1886
L. d. gaigae Dunn, 1937
L. d. micropholis Cope, 1860

I have followed Smith and Taylor (1945: 82) in the nomenclature of the Mexican subspecies.

Coluber leberis AND *C. ovivorus* LINNAEUS, 1758

As we resurvey the names applied by Linnaeus to his U.S.-Canadian specimens we find two others that require consideration. The first is *Coluber leberis* of the tenth edition, described from a Kalm specimen. For a long time herpetologists were at a loss to place this snake, and therefore followed Linnaeus' brief description, with some additional information said to have been given by Kalm. Finally Holbrook (4, 1840: 105; 4, 1842: 49) assigned the name to the queen snake, currently known as *Natrix septemvittata* (Say), 1825, and for many years *leberis* replaced Say's name as the recognized name of that snake. Eventually *leberis* was again displaced by *septemvittata,* as the name of the queen snake, because of the uncertainty of its applicability to that snake. As to the correctness of this decision there can be no question; the snake described by Linnaeus had 110 ventrals and 50 subcaudals, too few of either to have been a queen snake.

There is, in fact, only one genus found in the area traversed by Kalm to which the type could have belonged. This is *Storeria,* for this is the only genus in that territory represented by snakes having as few as 110 ventrals. However, the species might be either *S. occipitomaculata* or *dekayi.* The probabilities favor the former for two reasons: First, Linnaeus' pattern description "bands consisting of black lines" seems to fit it better; and, sec-

ondly, specimens of *occipitomaculata* with as few as 110 ventrals are without question of more frequent occurrence [13] than those of *dekayi,* although this count is quite low for either snake. But in view of the impossibility of deciding with absolute certainty which of these two species Kalm collected for Linnaeus, I do not recommend disturbing their long-established names.

Referring to Tables I and II, in which are listed the Linnaean types derived from Kalm and Garden, it will be observed that, of the names not considered to represent valid forms by Stejneger and Barbour in the fifth edition of the *Check List,* I have recommended the restoration of two, *doliatus* and *ordinatus,* and against the application of another, *leberis.* Two remain to be touched on: *Lacerta quinquelineata*, based on a Garden specimen, and *Coluber ovivorus,* received from Kalm. With regard to the former, Taylor (1935: 188) considers *L. quinquelineata* to be a synonym of *L. fasciata* (=*Eumeces fasciatus*) Linnaeus, 1758, which was included in the tenth edition of the *Systema* upon the authority of Catesby, without Linnaeus having seen a specimen.

Coluber ovivorus has been a long-neglected name and must remain so for lack of adequate data. Linnaeus gives no description beyond the scale counts, 203 ventrals and 73 subcaudals. There is a secondary reference to a Brazilian snake crudely described by Piso in 1648, which can have no relationship with any snake collected by Kalm in the northeastern United States. Daudin (6, 1803: 341) and several other early French herpetologists apparently thought that Linnaeus had a specimen of the snake now known as the horn-snake, *Farancia;* but Kalm would not have had access to this species and Linnaeus' figure for the subcaudal count is too high for *Farancia.* The best candidate seems to be the fox snake, *Elaphe vulpina,* to which Kalm probably would have had access in Ontario. But even this fits none too well, for Conant (1940: 9) gives 71 as the highest number of subcaudals found in his study of the fox snake. While 73 might be reached in a larger series, we are certainly not justified in applying the name *ovivorus* to the fox snake on such inadequate evidence.

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[13] This in turn is the result of two factors: first, *occipitomaculata* is the more common snake in the area traversed by Kalm; secondly, from the original scale-count data that Trapido (1944) used in preparing his monograph on *Storeria,* which data he was kind enough to lend me, I deduce the proportion of snakes having 110 (or fewer) ventrals to be 4 times as high in *occipitomaculata* as in *dekayi,* again restricting consideration to the snakes occurring in the Kalm area.

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The Systematic Status of the Crocodile *Osteoblepharon osborni*

By Robert F. Inger

THE validity of the crocodilian genus *Osteoblepharon,* described by Schmidt (1919), has been questioned by Chabanaud (1920) and Kälin (1933) on the basis of comparisons with skulls of the related genus *Osteolaemus.* These authors regard *Osteoblepharon osborni* Schmidt (type locality Niapu, Upper Congo) as a synonym of *Osteolaemus tetraspis* Cope (type locality "Ogobai River, West Africa"=Ogowe River). A new adult specimen from Beni in the Upper Congo, and five of varying ages from West Africa, afford an opportunity to examine the characters thought to distinguish the two genera and to form an opinion as to the status of the two species. The following is a list of specimens examined in the course of this study.[1]

No.	Locality	Snout-quadrate length
CNHM 17601	Atakpame, Togo	56 mm.
CNHM 44410	Oda, Gold Coast	61 mm.
CNHM 44442	Oda, Gold Coast	90 mm.
AMNH 7766	Lagos, Nigeria	140 mm.
AMNH 24740	West Africa	170 mm.
AMNH 29889	Bungulu (near Beni), Belgian Congo	190 mm.
AMNH 10083*	Niapu, Belgian Congo	190 mm.

* A paratype of *Osteoblepharon osborni.*

In describing *Osteoblepharon,* Schmidt distinguished it from *Osteolaemus* on the basis of the following characters:

1. No nasal septum
2. Palatines narrow, sides sub-parallel
3. Snout not raised anteriorly
4. Pterygoids produced forward into the palatal fenestrae
5. Frontal entering the supratemporal fossae
6. Maxillo-premaxillary suture transverse

In addition Schmidt stated that in the type specimen of *Osteoblepharon osborni* (AMNH 10082) the pterygoids were fused with no trace of a suture.

Kälin attacks the importance of the nasal septum as a diagnostic character by citing the fact that the degree of ossification is subject to much individual variation in *Alligator* and may also be so in *Osteolaemus.* Chabanaud, in describing a specimen from Diani, French Guinea, observed that the septum was incomplete, the nasals projecting forward to approximately the center of the opening, the premaxillaries backward to almost the center. There is some variation in this respect in the West African specimens available to me. In the smallest of these (CNHM 17601, 44410, and 44442), the

[1] I wish to express my appreciation to Mr. Karl P. Schmidt for his advice and helpful criticism. I also wish to thank Mr. Charles M. Bogert, of the American Museum of Natural History, for the loan of material and Mr. Arthur Loveridge, of the Museum of Comparative Zoology, for information on one of the paratypes of *osborni.* The skulls of five of the above-listed specimens were prepared by Mrs. Dorothy Foss, of the Chicago Natural History Museum.

septa are only one-half complete; but cartilage bridging the gap between the nasals and premaxillaries was observed during the preparation of these skulls. In AMNH 7766 and AMNH 24740 the septum is approximately four-fifths complete. It appears likely that the degree of ossification in the septum is dependent on age in the West African material. However, in all the Upper Congo skulls, all of which (including the type, snout to quadrate 169 mm.) are as long or longer than the largest West African skull, the bony septum is less than one-fourth complete. The conclusion is that the West African specimens continue a process of ossification that is halted at an early period in the ontogeny of individuals from the Upper Congo. A similar phenomenon appears in connection with the growth changes in the palatines.

The palatines of *Tetraspis*, as shown by Schmidt's figure, are constricted in the center and dilated posteriorly, contrasting with the uniformly narrow, parallel-sided bones of *osborni*. Both Mook (1921) and Kälin attributed constricted palatines to *tetraspis*. Kälin, though placing *osborni* in the synonomy of *tetraspis*, does not mention the form of the palatines in Schmidt's figured type. The palatines of the West African juveniles (i.e., *tetraspis*) are narrow and do not flare posteriorly. However, the palatines of the larger West African individuals show an increasingly greater development of their posterior part with an increase in size. This development involves not only widening but also deepening, so that a large bulb is formed in the posterior part of the palatines. The Congo skulls, both of which are larger than those from West Africa, have the palatines uniformly narrow throughout their length, as figured by Schmidt. There is no palatal bulb in the Congo specimens. Thus, in the palatines also, there is a sharp distinction between the West African (*tetraspis*) and Upper Congo (*osborni*) specimens, a distinction dependent upon a difference in the growth pattern.

The significance of the profile of the snout was questioned by Kälin because he believed the profile to be subject to change with age. The skulls before me bear out Kälin's belief; however, contrary to his expectation, the turning up of the end of the snout in the West African skulls is more pronounced in the older than in the younger ones. The Upper Congo skulls differ from the larger West African ones in not having the tip of the snout turned up. In this character also the distinction between *tetraspis* and *osborni* is maintained.

In the *tetraspis* skull figured by Schmidt, the palato-pterygoid suture is at the level of the posterior end of the palatal fenestrae. By contrast the figure of *osborni* shows the pterygoids produced forward so that the entire suture is anterior to the end of the fenestrae. Chabanaud's specimen has the lateral edges of the suture at the level of the end of the fenestrae whereas the median portion of the suture is anterior to that point. Examination of my material indicates a considerable amount of individual variability in this character. If the part of the pterygoids projecting into the fenestrae is divided by the length of the fenestrae and the ratio then plotted (Fig. 1) against the snout-quadrate dimension, there seems to be a relation between the ratio and size in the West African specimens. The Upper Congo specimens apparently do not fit into the same pattern. Although the data are not conclusive, the differences in growth pattern apparently follow those found in the preceding characters.

According to Schmidt, *osborni* can be distinguished from *tetraspis* by the transverse nature of the premaxillo-maxillary suture of the former. The suture in *tetraspis* has been described as V-shaped. In the series of skulls from West Africa there is a gradation in the suture from transverse to V-shape as the skulls increase in size. The two Upper Congo skulls agree with the type of *osborni* in having the suture transverse. Here again the distinction between the two groups of skulls is in the growth pattern.

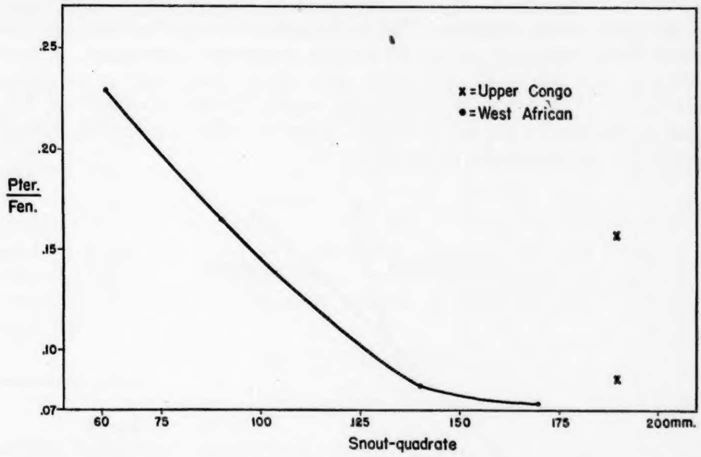

Fig. 1. The relation between the ratio pterygoid/fenestrae and snout-quadrate length. For fuller explanation of ratio see text.

Several other diagnostic characters employed in the original description of *osborni* do not hold up under examination. For example, only the type of *osborni* has the frontal entering the supratemporal fossae. In none of my specimens does the frontal participate in the fossae. The absence of a suture between the pterygoids of the type of *osborni* was thought to be of importance in defining the species. However, in all of the skulls I have seen, there is a suture separating the two pterygoids. Mr. Arthur Loveridge has informed me that this suture is also present in a second paratype of *osborni*. Obviously these two characters are of no importance taxonomically.

In the course of this investigation, several new differences have been observed. Returning to the palatal fenestrae, in the Upper Congo specimens the lateral borders are smooth curves without interruption. However, in the larger specimens from West Africa, the anterior part of the ectopterygoids sends a projecting flange into the fenestrae. This distinction appears in Schmidt's figures, although he does not mention it in his diagnosis. The fenestrae of the smallest West African skull are essentially identical to those of the Upper Congo skulls. The flange becomes increasingly apparent as the West African skulls increase in size. This is another distinguishing character in

which the adult West African specimens show "deviation" from the Upper Congo group in the sense that the term is used by De Beer (1940).

One more diagnostic character is offered by the scutellation. Considering only the supracaudal scales anterior to the point at which the tail crest becomes single, the counts for the type and two paratypes (one of which is included in my material) of *osborni* are given by Schmidt as 14, 12 and 13. Without exception every West African specimen I have seen has 11 such supracaudals. The Upper Congo specimen (AMNH 29889) not included in Schmidt's counts has 13. Thus a separation of the two groups can be made on the basis of this character. The supracaudals posterior to the point mentioned above vary from 17 to 19 without geographic association. Schmidt indicated that one of the paratypes had but 12 "posterior" supracaudals; this individual, which is included in my series, has the tip of the tail damaged, accounting for the low number of scales. In other respects the scutellation of the two geographic groups is similar.

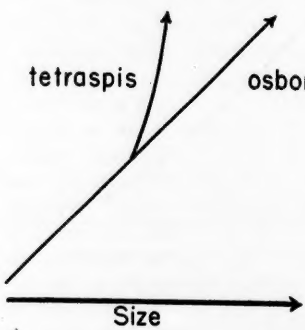

Fig. 2. The relations of skull growth patterns of *Osteolaemus tetraspis* and *O. osborni.*

The geographic distribution remains to be discussed. If the localities of my material, Chabanaud's specimen, and the type localities of *tetraspis* and *osborni* are considered, relative to the tropical rain forest, an important distinction becomes evident. The specimens referred to as "West African" occur in the coastal streams of the rain forest and may even be found in the savanna country, whereas the Upper Congo form is apparently limited to the uppermost tributaries of the Congo in the rain forest. It may also be significant that there is no overlap in the distribution of the two forms.

Validity of the Species *osborni*

I can only conclude from the significant and constant differences between the West African and the Upper Congo series of crocodiles that *tetraspis* and *osborni* are fully distinguishable as species. While they are to a degree geographically representative, it seems preferable to maintain them as distinct species until their distribution is better known. Considering the skull characters, *osborni* is apparently the more generalized and primitive form from

which *tetraspis* has "deviated." The relations of the skulls of the two could be pictured as in Figure 2. The skull characters of young *tetraspis* are essentially those of adult (and presumably also young) *osborni*. The palatal bulb of large *tetraspis* is a specialized structure(see discussion in Schmidt, 1932, of a similar development in *Crocodylus porosus*). This is one reason for designating *osborni* as the more generalized. Recalling the zoogeographic principle that the tropical rain forest may serve as a refuge for primitive forms, the distribution of the two forms in Africa also somewhat vaguely supports the interpretation of *osborni* as primitive.

Generic Untenability of *Osteoblepharon*

With respect to the tenability of generic distinction between the two forms the case is quite different. The distinction between the two species is of the nature of a deviation during growth of a series of characters. When one considers the classification of the remaining genera of Crocodilia, this difference is not great enough to warrant placing them in different genera. In conclusion, then, these two species are regarded as clearly belonging to a single genus in which they stand as *Osteolaemus tetraspis* Cope and *Osteolaemus osborni* (Schmidt). This conclusion, so far as taxonomic arrangement is concerned, has been independently reached by Mertens (1943) and Werner (1933).

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Additional Observations on Home Ranges and Longevity in the Lizard *Sceloporus graciosus*

By Robert C. Stebbins

In the summer of 1942, I marked a population of mountain swifts, *Sceloporus graciosus,* in a section of the Chaos Jumbles of Lassen Volcanic National Park, California. Individual lizards were rendered permanently recognizable by removal of toes in varying combinations. In 1942 and in subsequent years data have been gathered on this original group and additional lizards have been marked. In this way, it has been shown that the species at Lassen is of sedentary habits, individuals tending to remain for many years in relatively circumscribed areas, usually less than 100 feet in greatest dimension. This fact and others having to do with rate of replacement in the population, growth, and habits have been reported in previous papers (Stebbins, 1944; Stebbins and Robinson, 1946). The present report records additional information relating to the fate of marked animals.[1]

From August 6 to 10, 1947, in the area of study delimited in 1942, a total of 73 individuals was captured and then released. Of this number, 8 had been marked in 1942 and 10 in 1945. The remainder were unmarked. Persistent search of the area over a period of three months in 1942 brought to light 119 individuals exclusive of the season's young. Assuming a constant population size through the years, it is probable that 13 (11 per cent) of the original group was still present as based on the percentage of animals marked in 1942 among the random sample. In the same manner the number of individuals of the group marked in 1945 and still in the area may be roughly estimated. Ten of the 35 marked were recaptured. This number is approximately one-seventh of the random sample obtained in 1947. On the basis of probability, 17 individuals would be expected in the assumed total of 119, approximately 50 per cent of the original number. In 1945 it was estimated that one-third of the group marked in 1942 was present after a lapse of three years. Thus a decline to about one-half the number marked in 1945 after two years is reasonable. These estimates suggest that the number present in 1942 may have been halved during the first two years, was reduced to one-third the third year, and declined to about one-tenth by the fifth year. The rate of decline indicated is, of course, entirely a matter of speculation, since the actual number of individuals within the study area during these years was not known.

Longevity

In a previous paper (Stebbins and Robinson, 1946) it was estimated that one out of every 3 lizards of the original group of 1942, captured in 1945, was at least six years old. Of the 10 individuals recaptured in 1947, marked in 1945, 3 were at least four years and the remainder three years of age. Of the 8 individuals of 1942, one was at least six years old, 5 not less than seven and 2 eight years or older. The ratio of these older lizards (three years of age when marked in 1942) in the remnant of the group of 1942 is one in

[1] Mr. William Riemer kindly aided me in this survey.

four. All the animals of 1942 had a dull dorsal pattern. Obscuring of the dorsal markings with age is indicated. They were recognized before capture by behavior as well as pattern, since they were exceedingly wary and difficult to catch. Younger animals could usually be noosed immediately or after a short chase. Timidity and alertness was probably an outgrowth of years of experience in escaping predation and hazards of the physical environment.

Home Areas

Nearly all recaptures were made in or near home areas as previously determined. Distances from the nearest point on the boundary of home ranges are given below.

Specimen number	Size (snout-vent in mm.)			Estimated minimum age (in years)	Distances from boundary of original home area (in feet)
Males					
	1942	1945	1947		
6	Aug. 3–55	July 11–55	Aug. 7–55	8	6, 10, and 40
14	June 23–?		Aug. 7–54	7	1770*
23	Aug. 27–50	July 20–54	Aug. 10–55	6	within home area
74	July 22–51	July 20–53	Aug. 8–53	7	18
82	July 20–51	July 20–53	Aug. 6–53	7	40 and 75
105	Aug. 19–53 also Aug. 31, 1943–55	July 20–55	Aug. 6–65	7	15 and at edge of home area
158		July 18–48	Aug. 8–56	3	160
160		July 18–48	Aug. 6–53	3	140, 82, and 92
168		July 18–37	Aug. 6–54	3	within home area
174		July 18–51	Aug. 7–55	4	33
185		July 20–52	Aug. 8–52	4	1200*
Females					
8	Aug. 17–55		Aug. 6–55	8	1700*
84	July 30–52	July 19–55	Aug. 7–56	7	15 and at edge of home area
161	July 18–48		Aug. 8–53	3	51
165	July 18–32		Aug. 7–51	3	2, 42
171	July 18–35		Aug. 7–54	3	80, 20
177	July 19–46		Aug. 8–54	3	within home area
189	July 22–50		Aug. 6–53	4	19

* Probably in error (see p. 22).

Three individuals were recorded over 1000 feet from original areas. There may have been an error in my records for two of them (Nos. 8 and 14) since their positions were interchanged and they were marked on the same day. In view of the absence of shifts of such magnitude among all previous data, it appears that if not in error the shifts may have resulted from transportation by predators or man. The present and earlier studies, however, indicate that there may be slight shifts in home ranges of some individuals. That such movements may result in part from changing intraspecific pressures is suggested by the following observation. An adult male, No. 6, had reached full growth by August 17, 1942. It was probably at least three years old at that time. Ten observations, from June 23 to August 17, 1942, made possible determination of its home range with considerable accuracy. Another male, No. 5, of similar size, occupied an adjacent smaller area. Ten observations, from June 23 to August 13, indicated a cruising zone for this lizard about one-sixth the size of that of No. 6. The area of No. 5 included more bushes and surface litter than that of No. 6. Activity of No. 5 centered around a willow clump, to which it usually ran when frightened. To my knowledge, No. 6 never entered the zone of No. 5 except once, when chased. It then intruded only peripherally and remained only a few moments. On August 7, 8, and 10, 1947, No. 6 was seen in the region formerly held by No. 5. Number 5 could not be found and may have been eliminated. May it be that No. 6 in previous years had been denied the more optimum zone by No. 5 and with its disappearance had moved in? The area occupied by No. 6 in 1942 consisted largely of bare rocks with a few scattered conifers. The region almost wholly lacked bushes and surface litter that would attract arthropod food and provide cover.

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On the Mechanics of Spitting in the African Spitting Cobras

By C. W. Horton

THE purpose of this note is the application of physical principles to the examination of the "spitting" action of the African cobras, *Naja nigricollis* Reinhardt and *Hemachatus haemachatus* Lacépède. From observations of the maximum distance to which a cobra can spit, it is possible to deduce the pressure in the poison gland, and finally an estimate can be made of the tension in the masseter muscles.

Suppose that a cobra has been induced to spit several times at a distant target. Let s be the distance from the snake to the farthest point on the ground at which the poison falls. Since the distance s refers to the greatest distance, it is very probable that the poison was emitted at an angle of 45° with the ground. In this case the velocity, v, of the poison as it leaves the fangs is given by

$$v = \sqrt{980\,s} \quad \text{cm/sec} \tag{1}$$

provided the distance s is measured in centimeters. The value 980 is the acceleration of gravity in cm/sec^2. If allowance were made for the effect of air friction, the initial velocity would be larger; but this refinement seems unwarranted in view of the limited accuracy in s.

Ditmars (1944: 167) describes some measurements of the distance that a specimen of *N. nigricollis* can spit. By observing the poison on a smooth concrete floor, he obtained a value of 12 feet or 360 cms. On the other hand, Loveridge (*in* Bogert, 1943: 350) considers the approximate distance for this species to be 6 feet. Corresponding to these two values one finds v equal to 600 cm/sec and 420 cm/sec, respectively.

Since these cobras discharge a substantial amount of venom through a small discharge orifice, the transient effects of starting and stopping the flow are negligible. There is a theorem in fluid dynamics discovered by Daniel Bernoulli that is very useful in problems connected with fluids (Lamb, 1945: 21). This theorem states that in many circumstances the quantity

$$p + dv^2/2$$

is a constant during the motion of a fluid. Here p is the pressure, d is the density, and v is the velocity of the fluid. A small element of fluid that leaves the discharge orifice at a velocity v and a pressure zero was originally in the poison gland at a velocity zero and a pressure p. Thus the pressure p in the gland during the act of discharge is given by

$$p = 490\,ds \quad \text{dynes}/cm^2 \tag{2}$$

In this equation d, the density in grams/cm^3, is numerically equal to the specific gravity of the poison. The pressure, p, in equation (2) is known technically as the relative pressure. It is a measure of the difference between the fluid pressure in the gland and the atmospheric pressure.

The writer has not been able to locate any measurements of the density of the poison. Since the poison gland is a salivary gland, it is assumed, for

lack of better data, that the density of the fluid is the same as human saliva, which is near unity.[1]

Thus one concludes that during the act of spitting, the snake is able to develop a pressure in the poison gland of 180,000 or 90,000 dynes per square centimeter according as the maximum distance s is 12 feet or 6 feet, respectively.

Since the poison must travel through a long slender venom canal at a velocity of 400 to 600 cm/sec, it is necessary to make a correction for the effect of viscosity. This correction will increase the pressure in the glands by an amount Δp given by

$$\Delta p = 8\mu l v / a^2 \quad \text{dynes}/cm^2 \tag{3}$$

where

μ = viscosity of the poison in poises
l = length of venom canal, cm.
a = radius of the venom canal, cm.
v = velocity of the emitted fluid; given by equation (1).

C. M. Bogert (1943: 345, fig. 67) shows a cross section of a fang of *Hemachatus haemachatus* for which $a = 0.017$ cm. and $l = 0.5$ cm. If the viscosity of snake poison is the same as that of water, $\mu = 0.01$ poise, then the correction for viscosity would be 90,000 dynes/cm^2 for the case of $s =$ 12 feet. The correction is 60,000 dynes/cm^2 when $s = 6$ feet.

It is concluded that the cobras must develop a pressure of 270,000 or 150,000 dynes/cm^2 in the poison gland when they spit a distance of 12 feet and 6 feet, respectively. These figures are qualified by the fact that the density and viscosity of water have been used as approximate values for the density and viscosity of the venom.

The magnitude of the pressure may be more readily visualized if it is expressed in kilograms weight. The values 270,000 and 150,000 dynes/cm^2 are equal to 0.28 and 0.15 kg. wt./cm^2, respectively. Atmospheric pressure is normally about 1 kg. wt./cm^2.

It is interesting to interpret these pressures in terms of muscular forces. This interpretation is made in accordance with the following description supplied to the writer by Mr. Arthur Loveridge, who writes "I think the simplest comparison of the glands and poison duct is to a water pistol, the barrel corresponding to the duct, the rubber butt to the gland, and the human hand to the surrounding pressure-exerting masseter muscles."

Fortunately, it is not necessary to know the exact size or shape of the venom gland in order to make the calculation. It is sufficient to assume that when the poison gland is cross sectioned by a plane at right angles to the direction of the masseter muscles and located at the point where the gland is largest, the cross section of the gland is approximately a circle of radius r surrounded by a muscular wall of thickness t. Under these very general assumptions it can be shown that the tensional force, T, required to produce a pressure, p, in the gland is given by

$$T = rp/2t \quad \text{dynes}/cm^2 \tag{4}$$

It should be noted that this tension is a force per unit area and not the total force, which is the quantity often tabulated by biophysicists.

1 I find a value for the specific gravity of venom, presumably that of the western diamond-back rattlesnake given by Crimmins (1945: 56), as 1.030 to 1.050. Since this value differs from my assumed figure by less than the limits of error in other data, it is unnecessary to alter the calculations for the purpose of the present paper.

Since the writer does not have access to any cross sections of the glands and masseter muscles, it is necessary to estimate the ratio r/t in order to arrive at a final value of the tension in the muscles. Corresponding to the plausible value of 0.1 for the ratio t/r, one finds

$$T = 1{,}350{,}000 \text{ dynes/cm}^2 = 1.38 \text{ kg. wt./cm}^2 \text{ if } s = 12 \text{ feet}$$
$$T = 750{,}000 \text{ dynes/cm}^2 = 0.77 \text{ kg. wt./cm}^2 \text{ if } s = 6 \text{ feet}$$

These appear to be reasonable values, since they are about the same as the tension in the human arm when lifting a mediumly heavy weight.

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Notes on the Spawning Activities and the Young Stages of *Plancterus kansae* (Garman)

By William J. Koster

The plains killifish, *Plancterus kansae* (Garman), was found spawning in northeastern New Mexico on August 16–18, 1939, in a small, unnamed tributary of the "Dry" Cimarron River on Route 18, a few miles north of Moses, Union County. Spawning and several related activities were observed during the early afternoon of August 16, and the activities preceding spawning during the morning of August 18. A few observations were made about noon on August 17.

At the time of our visit this stream was small and clear. It was shallow with an occasional deep pool. It varied from 3 feet wide and ¾ inch deep to 15 feet wide and 4 feet deep, but was mostly between 4 and 7 feet in width and about 2 inches in depth. The bottom was composed chiefly of gravel with some areas of sand and rubble and with a few scattered boulders.

The current was moderate. Macroscopic vegetation consisted of a few scattered patches of Characeae and a very sparse growth of a filamentous alga upon the stones.

The pool in which spawning was observed was about 100 feet in length and varied from 4 to 8 feet in width and from 2 to 4 inches in depth over most of the area. A maximum depth of 10 inches was reached beneath a boulder near the upper end of the pool. The bottom was of gravel with the interstices filled with sand and silt. The current was slow.

Spawning Activities

During the earlier part of the morning of August 18, before the water temperature had risen, the males were amicable and wandered about feeding in small groups. As the water warmed, however, they tended to isolate themselves and to attack others of their own sex that approached too closely. No specific territory seemed to be guarded for any great length of time but rather a certain amount of "elbow room" was maintained. As a rule when two males met, the larger pursued the smaller for several feet. A deferred-combat ceremonial was noted twice. On each occasion two males of equal size met, erected their fins, and arranged themselves in parallel positions between 3 and 4 inches apart. This posture was maintained for almost a second until one fish moved about 8 to 10 inches forward, stopped, and faced about. Its opponent then moved forward along a path paralleling that of the first and likewise faced about, the two thus ending in a position the mirror image of the original. These short, parallel swims and about faces were repeated several times in each of the two ceremonials observed. The fish finally parted without coming to blows, and apparently without settling the issue.

The females wandered about the pool, feeding from time to time, and mating upon occasion. The approach of a male would sometimes result in a rapid flight on the part of the female, or if she were (it was presumed) more nearly ready to deposit a batch of eggs, in less rapid flight, which apparently stimulated the male to perform his courtship antics. These did or did not result in mating, more often not, because of the interference of rival males.

The spawning act was rather simple. The male placed himself alongside the female whenever she came to a halt and both turned on their sides with the male on top. Both then assumed a flattened S-shape, with the head end and the anal region of the female appressed to the bottom and the thoracic and caudal portions elevated. While in this position both fish vibrated rapidly for approximately a second. Presumably they emitted the sex products at this time although these could not be seen even through field glasses.

Several characteristic actions on the part of the males were associated with spawning. Particularly vicious lunges were made by rival males at males that were courting females. A pair would not be together long before an intruder would be certain to arrive and attempt to disrupt the proceedings. The responses of a male toward a ripe female varied. At times the male would swim rapidly around the female in circles approximately 18 inches in diameter while at other times the male would move in a very ser-

pentine path in front of the female as she moved slowly along. These performances sometimes alternated on a refractory female. Both of these actions appeared designed to induce a halt on the part of the female so that the male could approach and assume the spawning position. Another courtship tactic of the male consisted of his swimming very close above the female about a head-length behind and slightly to one side. While in this position the male is ready to mate immediately upon a pause by his partner. This last course was pursued more frequently after a successful mating than before. Once, while a pair was travelling in this fashion, the female hesitated several times and appeared to pick something off the bottom. Each time she did so the male attempted to mate. The female was probably feeding as both sexes were seen to feed between spawning acts. After a successful spawning act a male usually repeated the courtship performances described above, seemingly in an effort to induce another spawning, but in all observed cases the consummation of the second act was prevented by the appearance of a rival male who separated the pair by means of a swift attack. Both sexes were promiscuous in their breeding behavior.

As indicated by Hubbs and Ortenburger (1929: 40), the male is much more brilliantly colored than the female. That sex recognition may be made on the basis of activity rather than on color, however, is suggested by the following event. A female entered and stopped in very shallow water to elude a male while the male who had been following settled to the bottom, in slightly deeper water. Another male came over and, observing the resting male, tried to assume a spawning position next to it. When the first male reacted the wrong way, all three fish went off in a mad whirl.

The water temperature was 82° F. at 11:05 A.M. shortly before spawning was seen on the first day of observation. The last spawning that same day occurred at 1:10 P.M. although observations were continued until 2:15 P.M. The males were no longer quarrelsome and had not been most of the time since the last observed mating. The next day the stream was revisited with the hope of making further observations. It was not possible to arrive before noon by which time the water temperature had reached 88°. No signs of spawning could be seen and the males were not pugnacious. The following morning temperatures were taken at intervals from 6:30 A.M., when it was 66°, until 10:15 A.M., when it was necessary to leave. Unfortunately, the temperature at the critical time when the first signs of interest in spawning, i.e., of combativeness, occurred, is suspected of being inaccurate. The last unquestionable reading was 71° at 8:45 A.M. While these times and temperatures are too few to be significant, they at least suggest the interesting possibility that the temperature of the stream varies so much and so rapidly that the species is restricted to a relatively short period of spawning each day when the water temperature is within the species' range of tolerance. This is suggested as a possibility because no signs of spawning were apparent for over an hour after a thermometer reading of 71°. Mating was observed when the water temperature was close to 82°, but not when it was 88°. Other variables, such as the time of day, seemed balanced out.

The temperature at which *Plancterus kansae* spawns is probably more

consistent than is the time of spawning. The temperatures reported by Hubbs and Ortenburger (1929: 40) for Oklahoma collections, many containing very young, ranged from 82° to 84° F. According to these authors the Oklahoma samples taken as early as June 1 contained young of the year and most adults had spawned by July 11. The spawning in New Mexico as described above took place more than a month later, but at a higher elevation where the warm seasons are more retarded. A rather long spawning period is indicated for New Mexico as well as for Oklahoma, for the mid-August samples contained young in diverse stages of development, ranging from a 5.6 mm. prolarva to a 29 mm. young.

Comparisons

Observations on the spawning habits of the genus *Plancterus* do not seem to have been published, although there are several accounts of the reproduction of American species of the genus *Fundulus,* which according to Hubbs (1926: 14) is very similar structurally. Newman (1907: 315–331) described the reproductive activities of *Fundulus heteroclitus* (Linnaeus) in considerable detail, both from aquarium and field studies. Evermann and Clark (1920: 372), Greeley (1935: 97) and Richardson (1939: 165–167) published on *F. diaphanus* (Le Sueur), the first two on the basis of field observations, the last chiefly on aquarium studies.

The spawning act in *P. kansae* seems to have much more in common with that of *F. heteroclitus* as described and figured by Newman than with that of *F. diaphanus* as set forth by Richardson, though the positions of the fins of *P. kansae* were not seen clearly. Newman described the pair as assuming a flattened S-shape with the male clasping the female by interlocking his dorsal and anal fins with the corresponding fins of the female. Richardson indicated the male as being bow-shaped with the convex side toward the female.

The activities related to spawning in *Plancterus kansae* do not seem to agree wholly with those of any of the species of the family that have been studied, though elements of the behavior in *Plancterus* correspond with the known habits of different species of *Fundulus* and of other cyprinodont genera. Newman reported that the males of *F. heteroclitus* in the wild maintained spawning territories. Both Greeley and Richardson confirmed this finding for *F. d. diaphanus.* Evermann and Clark, working with *F. d. menona,* described the fish as swimming in pairs but said nothing about territories. Defense of the breeding territory has also been noted for *Cyprinodon macularius* by Cowles (1934: 41). The tendency to defend territories is poorly developed in *P. kansae,* since the males showed little inclination to guard a particular region for more than minutes at a time.

The habits of swimming in pairs as a courtship device was described in some detail for *F. heteroclitus* by Newman and for *F. d. menona* by Evermann and Clark. In these forms the upper member of the pair was the female although Newman reported that the male *F. heteroclitus* sometimes moves to the superior position and attempts to force the female to the bottom to spawn. *P. kansae* males tend to remain in the more favorable upper position at all times. Richardson observed pairing of this type in *F. d.*

diaphanus but did not describe the act in detail and Greeley did not mention such pairings. It is the only courtship tactic mentioned by Evermann and Clark for *F. d. menona*. According to Newman's account this same habit is conspicuous only in the first stages of courtship in *F. heteroclitus*. The males of *P. kansae* occasionally swam close to the female before mating, but as a rule only after having spawned once with a given female. The habit of pugnaciously darting about in front of the female and clearing all fish from a territory several feet in diameter, practiced by the *F. d. diaphanus* male according to Greeley, probably corresponds to the habit of the *P. kansae* male of swimming in a sinuous path in front of the female. In the *Plancterus*, however, this habit did not seem as much designed to clear away other fish as to slow down or halt the female by swimming in front of her. The color displays described by Greeley and by Richardson may correspond to what is here called deferred-combat ceremonial. The tendency of the male to encircle the female during courtship was not mentioned in any of the cited studies. Curiously enough, I have seen such action in the more distantly related Pecos River form of *Cyprinodon*, which maintains a territory and uses the circling device to hold the female within its bounds.

Descriptions of the Young Stages

Four of the diverse phases of development secured in mid-August are described in some detail as representative of the early phases of life. The larval stages are separated into prolarva and postlarva as was recently recommended by Hubbs (1943). Since the specimens had begun to fade before they were described and the colors other than black had become too faint to follow accurately, all references to pigment or pigment cells are to melanin and melanophores.

The measurements were made by means of a mechanical stage reading to 0.1 mm., following the method used on darters by Hubbs and Cannon (1935: 8–9). The formalin-preserved specimens were placed in a depression slide and moved until the position of measurement was in line with a pointer in the ocular. Most dimensions represent the distance from the tip of the snout to the vertical passing through the point indicated. With the exception of the measurement of the length of the dorsal and anal fin rays which were made in the usual fashion, the measurement of parts, such as the eye or height of finfolds, were made along a line parallel to or at right angles with the main axis of the body.

PROLARVA (Fig. 1)

The dorsal and anal finfolds are continuous with the caudal, which alone possesses rays. The rayless pectoral fins are large while the pelvic fin buds are not visible. Myotomes before anus, 10; behind anus, 24.

Pigmentation—A small group of melanophores shades the brain between the eyes. Over the posterior portion of the brain there is a large cluster of chromatophores which tapers caudally and extends internally along the spinal cord as a series of isolated spots. An irregular row of pigment cells, which decrease in size posteriorly, originates near the upper corner of the

operculum and extends along the side of the mid-dorsal line to near the base of the caudal fin. Several small pigment cells are scattered along the mid-dorsal line under the dorsal finfold. A few melanophores are present on the dorsolateral surfaces of the yolk-sac and a dense mass of black pigment occurs along the ventral side. A few small chromatophores are scattered along the caudal rays. A single row of relatively small melanophores extends along the mid-ventral line beneath the base of the anal finfold from the caudal to the vent and part way along the dorsal wall of the coelomic cavity.

In other specimens at a similar stage of development the patch on the ventral side of the yolk-sac is triangular with the apex toward the vent. At a slightly later period, soon before it disappears, this patch contracts laterally to form a thick irregular line from the now darkened pericardium to the vent.

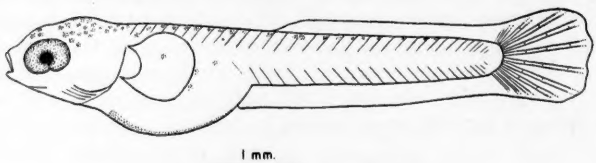

Fig. 1 Prolarva of *Plancterus kansae.*

Measurements in Millimeters.—Distance from tip to snout to base of caudal fin, 5.6; to end of caudal fin, 6.6; to front of yolk sac, 1.1; to rear of yolk sac, 2.8; to origin of dorsal finfold, 3.0; to origin of anal finfold, 2.5. Length of head, 1.3; diameter of eye, 0.5; length of snout, 0.2; depth of body through origin of dorsal finfold, 0.6; depth of body through center of yolk sac, 1.2; height of dorsal finfold, 0.1; height of anal finfold, 0.2; length of pectoral fin, 0.8.

POSTLARVA (Fig. 2)

Except for slight changes in the outline of the dorsal and anal finfolds and the greater development of rays in the caudal, the fins are essentially the same as in the prolarva. Myotomes before anus, 10; behind anus, 24. The lower jaw protrudes.

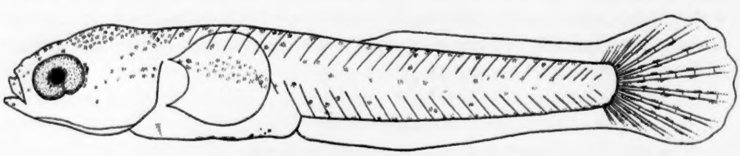

Fig. 2. Postlarva of *Plancterus kansae.*

Pigmentation.—A few chromatophores occur on the snout and premaxillaries. The two cranial pigment areas of the prolarva have become connected by a few melanophores. The series on either side of the back from the upper corner of the opercle to the tail are more or less doubled, especially near the

anterior end. Some melanophores are present along the mid-dorsal line between the two series anterior to the dorsal finfold, but none are now visible beneath that structure. The chromatophores on the dorsolateral aspect of the abdomen are more abundant than in the prolarva. Rather numerous melanophores are scattered along the sides of the body. On the posterior margin of the orbit there is a short vertical row of pigment cells. A more or less doubled series extends along the upper edge of the opercle. A few small melanophores are apparent beneath the lower portions of the preopercle and opercle. Several small chromatophores are present on the chin. The pericardium shows as a dusky triangle. A discontinuous intense black streak extends from the pericardium to a point just anterior to the vent. A row of melanophores extends caudad beneath the anal finfold. This is a single series except where doubled along the second quarter of its length. Each of the more developed caudal rays is outlined dorsally and ventrally by a row of melanophores. A few small pigment cells occur on the dorsal margin of the pectoral fin near its base.

Measurements in Millimeters.—Distance from tip of snout to base of caudal fin, 6.8; to end of caudal fin, 8.1; to origin of dorsal finfold, 3.9; to origin of anal finfold, 3.2; to origin of pectoral fin, 1.8. Length of head, 1.7; diameter of eye, 0.6; length of snout, 0.3; depth of body, 1.3; height of dorsal finfold, 0.1; height of anal finfold, 0.3; length of pectoral fin, 1.1.

YOUNG OF ABOUT 14 MM. STANDARD LENGTH

The pelvic fins are present and contain a few rays. The other fins have most of their rays well developed. The posterior margins of the dorsal and anal fins are fastened for most of their length to the caudal peduncle by remnants of the finfolds. Ten myotomes are present before the anus, but in this individual there are apparently only 21 in the tail.

Pigmentation.—The top of the head, including the upper surface of the premaxillaries, is rather densely pigmented. The sides of the snout and the chin have scattered melanophores. There is a concentration of pigment cells about each nostril and a vertical series extends along the posterior margin of the orbit. A black streak, visible through the opercle, extends diagonally upward. The iris, hitherto black, is now silvery. The upper one-fourth of the opercle and body is heavily dotted with pigment cells. The longitudinal series of pigment cells which were so conspicuous in the earlier stages on either side of the mid-dorsal line are still distinguishable by the greater size of the individual melanophores. Just anterior to the dorsal fin on the midline is a more conspicuous cluster of melanophores. A row of pigment cells extends from the caudal fin anteriorly to the anal fin where it bifurcates to pass on either side of the fin and reunites in front. A row of chromatophores extends along the upper and lower margins of each dorsal and each caudal fin ray. The pectoral and anal fins have scattered melanophores. The ventrals are colorless.

Measurements in Millimeters.—Distance from tip of snout to base of caudal fin, 13.9; to end of caudal fin, 17.1; to front of dorsal fin base, 8.3; to rear of dorsal fin base, 11.2; to front of anal fin base, 8.6; to rear of anal

fin base, 11.0; to origin of pectoral fin, 4.3; to origin of ventral fin, 7.1; to anus 8.0. Length of head, 3.8; diameter of eye, 1.2; length of snout, 1.0; depth of body, 2.7; height of dorsal fin, 0.8; height of anal fin, 1.0; length of pectoral fin, 2.2; length of pelvic fin, 0.5.

YOUNG OF ABOUT 18 MM. STANDARD LENGTH

This individual is essentially like an adult in general appearance. Scales are well developed and the fins seem to have their quota of rays.

Pigmentation.—The superficial chromatophores developing in conjunction with the scales more or less obscure the earlier markings on the top of the head. The sides of the snout, maxillaries and chin are sparsely dotted with melanophores. The top of the premaxillaries and the region immediately adjacent to the nostrils are rather densely pigmented. The postorbital series is now doubled. The deep opercular streak extends dorsally under the posterior edge of the preopercle and thence diagonally upward across the upper portion of the opercle at about its internal line of junction with the cranium. As in the smaller young specimen the upper part of the opercle and the body are covered with scattered melanophores. About ten vertical bars cross the back and sides of the body. They are not symmetrical on the two sides of the body. Posteriorly the bars extend from the mid-dorsal line almost to the ventral side. Anteriorly, they fail to reach either the mid-dorsal line or more than about half way down the trunk. The predorsal spot is intense. The fins are essentially the same as in the preceding specimen but are now more spotted than streaked.

Measurements in Millimeters.—Distance from tip of snout to base of caudal fin, 17.9; to end of caudal fin, 22.1; to front of dorsal fin base, 11.2; to rear of dorsal fin base, 14.0; to front of anal fin base, 11.2; to rear of anal fin base, 13.8; to origin of pectoral fin, 5.4; to origin of ventral fin, 9.4; to anus, 10.8. Length of head, 5.3; diameter of eye, 1.4; length of snout, 1.3; depth of body, 4.3; depth of caudal peduncle, 2.0; height of dorsal fin, 1.3; length of longest dorsal ray, 1.8; height of anal fin, 1.3; length of longest anal ray, 2.3; length of pectoral fin, 2.9; length of pelvic fin, 1.1.

COMPARISONS WITH YOUNG STAGES OF OTHER CYPRINODONTS

As might be expected from the similarity of the adults, the larval stages of *Plancterus* and *Fundulus* are very much alike. The differences that are observable between specimens of *P. kansae* and the descriptions and figures of *F. diaphanus* by Fish (1932: 356), and of *F. heteroclitus* by Oppenheimer (1937: 7–15) and Solberg (1938: 17–19) are mostly obscured by individual variations and growth changes. A distinction that seems to hold, except in the late larval stages, is the shape of the eye. The outline of the eye is distinctly elliptical in *Plancterus* whereas it is almost circular in *Fundulus*. Another, less trenchant difference is the more precocious development of pigment in the species of *Fundulus*.

The descriptions and figures by Kuntz (1916: 414–415) of *Cyprinodon variegatus* indicate that this species is much further advanced at any given size than either of the species of *Fundulus* or *P. kansae*. For example, the

prolarva, which already exhibits definite indications of the saddle markings of the adult, has a length (total length, presumably) of only 4 mm.; a postlarva measures but 5 mm.; and a young but 9 mm. in length shows many of the adult characteristics. Specimens of the early stages of *Cyprinodon bovinus* subsp., collected near Roswell, New Mexico, correspond closely with the descriptions of *C. variegatus*. Judging from this series of specimens, the origin of the dorsal finfold provides a trenchant character for distinguishing *Cyprinodon* from *Plancterus* since it is distinctly anterior to the anal origin in the former and posterior in the latter.

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A Northerly Record of *Polydactylus approximans* (Lay and Bennett), a Polynemid Fish of the Pacific Coast of Tropical America

By W. I. Follett

THE capture of a specimen of *Polydactylus approximans* in Monterey Bay, Monterey County, California, far north of any previous record, has prompted a review of the literature of this species.

Synonymy and Nomenclature

Polynemus approximans.—Lay and Bennett, 1839: 57 (original description; "Hab, apud San Blas et Mazatlán" [1] [Mexico]). Günther, 1868: 387, 423–424 (description; specimens from Chiapam [2] and Panama). Steindachner, 1870: 314 (dorsal spines 8; specimens from Mazatlán); 1876: 558 (description; Mazatlán and Acapulco [Mexico], Panama). Smith and Swain, 1882: 123 (comparisons). Jordan and Gilbert, 1882*a:* 365 (specimens from Cape San Lucas [Lower California]); 1882*b:* 376 (specimen from Panama); 1882*c:* 107 ("raton"; specimens from Mazatlán); 1882*d:* 111 (Panama). Gilbert, 1882: 112 (observed at Punta Arenas [Costa Rica]). Jordan and Gilbert, 1883: 590 (resembles *P. octofilis*). Jordan, 1885: 372 (common at Mazatlán and Panama); 1887*a:* 854 (Pacific coast); 1887*b:* 322 (*Polynemus californiensis* Thominot a synonym; probably from "about Cape San Lucas"). Eigenmann and Eigenmann, 1892: 353 (*Polynemus californiensis* questionably a synonym). Boulenger, 1899*a:* 7 (Bahía de Santa Elena, Ecuador; 1899 *b:* 3 (Gulf of Panama; Rio Sabana, Darien). Pellegrin, 1901: 163 (Gulf of California). Regan, 1906–1908: 73 (pectoral filaments 5 or 6; California to Ecuador); 1913: 279 (specimen from fresh water at Pacasmayo, Peru). Eigenmann, 1922: 244 (literature reference). Meek and Hildebrand, 1923: 290–291 (description; specimens from Taboga Island, Chame Point, Balboa, Corozal, and Panama City market, Panama). Hildebrand, 1925: 284 (specimens from Cutuco, El Salvador; range). Jordan, 1925: 441 (filaments 6; western Mexico to San Diego [California]); fig. 347 (shoulder girdle). Ulrey and Greeley, 1928: 31 [sep. p. 33] (literature records). Ulrey, 1929: 6 (southern California; Gulf of California). Jordan, Evermann, and Clark, 1930: 256 (Guaymas [Mexico] to Panama; Santa Catalina [Island] and San Diego [California]). Cuesta Terron, 1932: 78 (Gulf of California). Breder, 1936: 11 (specimens from Perlas Islands, Panama). Barnhart, 1936: 36 (diagnosis; tropical east Pacific, rarely to San Diego and [Santa] Catalina Island); fig. 124. Seale, 1940: 16 (counts; specimens from Mazatlán, Tenacatita, and Sihuatanejo, Mexico; Corinto, Nicaragua; Port Utria, Colombia). Hildebrand, 1946: 436–437 (synonymy; description; comparisons; specimens from Gulf of Guayaquil off Puerto Pizarro, Lobos de Tierra Island, and Tumbes River, Peru).

Trichidion approximans.—Gill, 1861: 275 (western coast of Mexico); 1862: 258 (specimens from Lower California); 1863: 169 (specimen from western coast of Central America).

Polydactylus approximans.—Jordan and Bollman, 1890: 180 (specimen from *Albatross* station 2800, off Panama). Kirsch, 1890: 233–236 (distinguishing characters; synonymy; Guaymas to Panama; specimens from Guaymas). Evermann and Jenkins, 1891: 137 (synonymy; specimens from Guaymas). Jordan, 1895: 425 (specimens from Mazatlán, where common on sandy beaches; used as food). Jordan and Evermann, 1896*a:* 829 (distinguishing characters; description; synonymy; Guaymas to Panama); 1896*b:* 335 (Guaymas to Panama). Abbott, 1899: 344 ("barbuda"; specimen from Callao, Peru). Jordan and Evermann, 1902: 261 ("raton"; distinguishing

[1] I designate Mazatlán, Mexico, as the restricted type-locality.
[2] A coastal lagoon ½ mile from Champerico, Guatemala, according to Griscom (1932: 415).

characters; San Diego to Panama). Gilbert and Starks, 1904: 63 (counts; measurements; specimens from Panama Bay); 210 (Gulf of California, Ecuador, Peru). Jordan, 1905: 226 (filaments 6; western Mexico to San Diego); fig. 178 (shoulder girdle). Starks, 1906: 783 (specimens from Guayaquil, Ecuador, and Callao, Peru, with anal soft-rays 15). Jordan and Starks, 1907: 68 (Mazatlán, Santa Catalina Island, and San Diego). Jordan, 1907: 441 (filaments 6; western Mexico to San Diego); fig. 347 (shoulder girdle). Evermann and Goldsborough, 1909: 103 (specimens from Taboga Island, Canal Zone, Panama). Starks and Mann, 1911: 10 (specimen from vicinity of San Diego). Kendall and Radcliffe, 1912: 89 (specimen from Panama City market). Wilson, 1916: 61 (specimens from Buenaventura, Colombia). Starks, 1916: 27 (sesamoid articular). Evermann and Radcliffe, 1917: 52 ("barbudo"; description; specimen from Tumbes, Peru); 53 (range; common food fish). Fowler, 1923: 297 (specimen from La Jolla [California]). Starks, 1926: 221–222 (osteology of ethmoid region; specific name misprinted *aproximans*); 1930: 194–195, fig. 18 (osteology of shoulder girdle; specimen from Mazatlán). Myers, 1936: 381 (generic relationship; specimen in U. S. Nat. Mus.). Kumada and Hiyama, 1937: 29 (field character; Central America and California). Tortonese, 1939: 285–286 [sep. pp. 109–110] (specimens from Rio Sabana, Darien; Gulf of Panama; Bahía de Ballenita, Ecuador). Fowler, 1942: 136 (literature reference); 1944*a:* 221–222 (synonymy; color; specimens from Playa Muerto, Panama); 244 (filaments 6; specimens from Santelmo Bay, Rey Island, Perlas Group, Panama); 384 (filaments 6; specimens from about 20 miles south of Mazatlán); 414 (specimens from Lat. 22° 03′ N., Long. 106° 42′ W.); 498 (records); fig. 144; 1944*b:* 89–90 (synonymy; "barbuda," "barbudo"; western Mexico to Peru); 1945: 204 (same as 1944*b*).

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Polynemus californiensis.—Thominot, 1886: 161–162 (original description; type-locality, "Californie"). Jordan, 1887*b:* 322 (synonym of *Polynemus approximans;* probably from "about Cape San Lucas"). Eigenmann and Eigenmann, 1892: 353 (questionable synonym of *Polynemus approximans;* California).

Polynemus approximatus (misspelling).—Beltran, 1934: 10 ("raton"; Guaymas southward). Lindner, 1947: 77 ("boca dulce"; Salina Cruz Market; Oaxaca, Mexico).

I follow Myers (1936: 381) in referring this species to the genus *Polydactylus* Lacépède (1803: 419).

The Monterey Bay Specimen

(Plate 1)

The present specimen (Stanford Natural History Museum No. 35305) was obtained from a commercial fisherman by J. B. Phillips on January 27, 1941, and was reported taken in a gill-net, together with *Genyonemus lineatus* (Ayres), "in Monterey Bay, near Monterey," California. As the foregoing review of the literature indicates that *Polydactylus approximans* has been recorded from Callao, Peru, to Santa Catalina Island, California, this specimen constitutes a northerly extension of the recorded range of more than 300 miles in a general coastwise direction.

The following data, taken in the manner described by Hubbs and Lagler (1941: 12–20, figs. 2–3), were obtained from this specimen: Standard length 187 mm. Dorsal VIII–I,12. Anal III,14. Pectoral filaments 6 on each side, the longest extending nearly to origin of anal. Pectoral rays 15 on each side, exclusive of filaments. Pelvics I,5 on each side. Principal caudal rays 9+8, the outermost unbranched and much shorter than the adjacent branched rays.

Vertebrae 10+14=24, as determined by X-ray. Gill-rakers 13+17 on each side. Scales (left) 7-58-12; (right) 7-60-12.

Other California Specimens

Another example of *Polydactylus approximans* was obtained by Harry H. Schryer at San Pedro, Los Angeles County, California, and a cast made from this specimen is on display in the Cabrillo Marine Museum at San Pedro (No. 2862).

From the records maintained by the California State Fisheries Laboratory at Terminal Island, the following additional California occurrences of this species were obtained:

1. One found in the San Pedro fish markets, reported taken locally by the boat "President." Standard length 148 mm. Recorded August 17, 1940, by Frances N. Clark.
2. One taken in a bait haul near the San Pedro lighthouse, Los Angeles County. Recorded October 5, 1940, by Phil M. Roedel.
3. One taken in the surf near San Clemente, Orange County, and sent to the Laboratory by Geo. Beamon Sporting Goods, Pomona. Standard length 211 mm. Weight 190 g., cleaned. Recorded May 8, 1941, by Frances N. Clark.
4. One taken in the surf at Seal Beach, Orange County, apparently by Otto Helmer. Standard length 193 mm. Weight 173 g., round. Recorded June 8, 1941, by Phil M. Roedel.
5. A maturing female taken in a bait catch at San Clemente, Orange County, by the boat "Virginia." Standard length 222 mm. Recorded July 28, 1941, by Frances N. Clark.
6. A maturing male taken with hook and line, on mussel bait, from the Belmont Pier at Long Beach, Los Angeles County. Standard length 222 mm. Weight 230 g., round. Recorded August 7, 1941, by Frances N. Clark.

The crania and vertebrae of these specimens have been preserved at the California State Fisheries Laboratory by Charles R. Clothier. All 6 have a vertebral count of 10+14=24.

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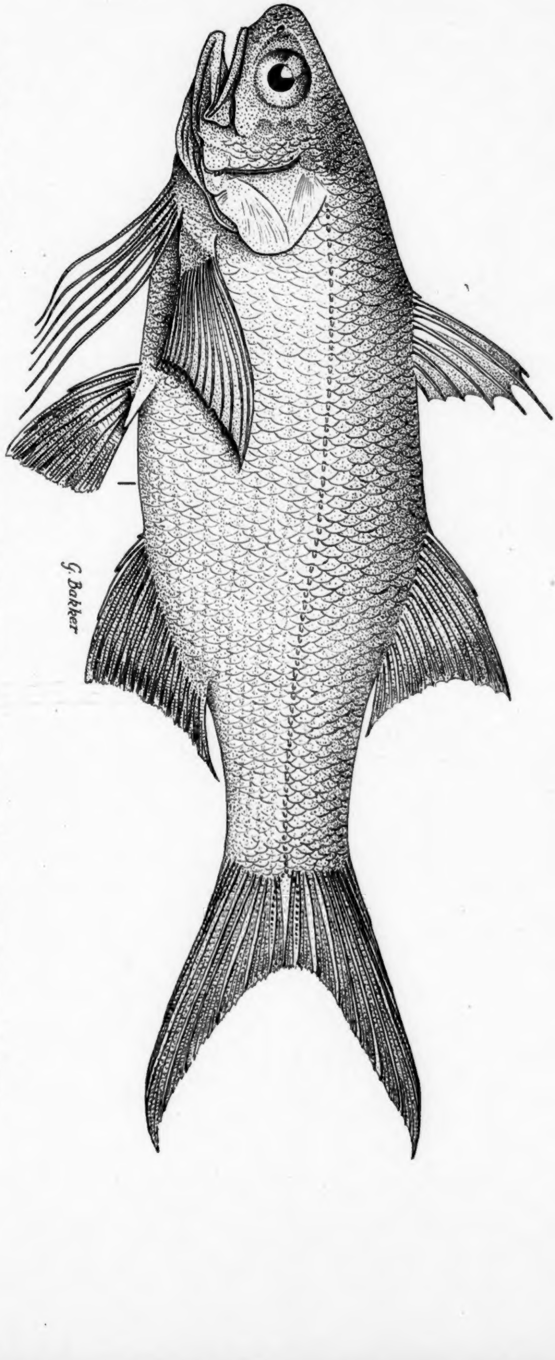

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Factors Affecting Population Levels in *Lebistes reticulatus*

By RALPH P. SILLIMAN

INTRODUCTION

OF primary interest to all concerned with the management of our commercial fisheries is the productivity of the fish populations at various levels of exploitation. In particular, it is nearly always desired to determine the "optimum catch," or in other words the level of fishing intensity, which will produce the greatest continuing yield of food for man. This might be determined by keeping the fishery at various levels of intensity for long enough periods to ascertain the average annual yield under each. Unfortunately, however, such a procedure is rarely feasible, since all commercial fisheries of importance involve the livelihoods of many people, who cannot be used as "guinea pigs," even for the long term benefit of future generations.

In view of the above facts, it seemed desirable to follow the lead of other branches of biology in which animals of little importance in themselves are used to evolve general principles which may be applied to man or to economically important species of animals. By using a small, rapidly reproducing fish, the experience which for commercially important fish populations covers thousands of square miles of water and years of time can be compressed within the confines of a laboratory room and a few months.

The experimental fish selected should be small in size, reproduce at frequent intervals, grow rapidly and be hardy enough to withstand experimental handling. Of the available aquarium fish, the common guppy, *Lebistes reticulatus,* seemed to come nearest to satisfactorily fulfilling these requirements. It was accordingly selected as the experimental animal for the present studies.

The general plan of the experiment was to start two populations, each with a single pair of fish, and to allow these to grow until they had reached stability under the conditions maintained in the laboratory aquaria. It was desired if possible to make the conditions such that the amount of food available would constitute the limiting factor to population growth, since this seems to be true in most large commercial fish populations. After stability had been reached, it was planned to apply various fishing pressures to one of the populations, using the other as a control. In this way the yield under each fishing intensity could be determined, and a relationship between intensity and yield could be set up. Also, since food would be measured, the efficiency of food conversion at each intensity could be evaluated.

Unfortunately, due to extraneous circumstances, the experiment was not carried on to completion. However, it is felt that the data obtained are of sufficient interest to warrant publication.

I am grateful for the encouragement, assistance and advice rendered by Dr. J. L. Kask, of the Steinhart Aquarium, and Mr. R. J. Lanier, formerly of that institution; by Mr. C. M. Breder, Jr., of the American Museum of Natural History; by Dr. H. H. Shoemaker, of the University of Illinois; and by Dr. Frances E. Felin, of the United States Fish and Wildlife Service.

Apparatus and Methods

Standard aquarium equipment was used throughout. The tanks themselves were of glass, with a water mass 27 cm. deep by 59 cm. long by 29 cm. wide (volume 46 liters). A small electric air pump operated a cotton charcoal filter for each tank. These filters were modified so that the filter outlet was at the opposite end of the tank from the inlet, instead of at the same end, as in the conventional installation. The pump also supplied air for an airstone at the center of the bottom of each tank. Heat was furnished by 60 watt aquarium heaters, and temperature was regulated by thermostats. The conventional aquarium thermostats with a short, straight bimetallic strip proved unsatisfactory, and were replaced by others with a long, coiled strip. The light source for each tank consisted of a long, narrow reflector with one 25 watt and one 40 watt showcase-type incandescent globe, each about 5 cm. above the water surface. During the course of the experiment, protection for the newborn fish was installed in each tank, consisting of a fence in one corner of the tank, 17.5 cm. long, made of glass rods 3 mm. in diameter and spaced 4.5 mm. on centers. Each of these fences enclosed a right isosceles triangular space 12.4 cm. on the sides adjacent to the right angle (the corner of the tank). Equipment was arranged in the tanks so that they were mirror images of each other.

Food and fish were weighed on a Torsion Balance. The method of weighing the fish was suggested by H. H. Shoemaker, and consisted of

pouring them into a cloth bag, allowing the excess water to drain off, and then weighing both bag and fish in a paper cup on the balance pan. Tare weight was secured by weighing bag and cup after returning the fish to the tank. This method of weighing resulted in no mortality of fish, except in two instances (one death in each instance), both traceable to improper manipulation of the apparatus. Weighing was done once weekly. Counting was accomplished by dipping the fish with a net from the tanks to separate jars, and was also done weekly.

Whiteworms (*Enchytraeus albidus*) were furnished as live food for the adult fish. They were cultured in flat enameled pans containing moist earth, and fed on milk-soaked bread and baby cereal. Before being fed to the fish, the worms were rinsed in fresh water, dried on paper toweling, and weighed. Due to waning of the whiteworm cultures, it was necessary to substitute chopped earthworms (*Lumbricus terrestris*) and dungworms (*Allolobophora foetida*) during the last month of the experiment.

Live food for the young fish, but consumed also by adults, consisted of newly hatched nauplii of the brine shrimp (*Artemia salina*). These were cultured in battery jars containing two liters of salt water (38 grams rock salt per liter of water). Jars were placed in a water bath thermostatically maintained at 24°C. In each jar 0.3 gram of encysted eggs was placed, and allowed to stand 48 hours. The hatch of nauplii was siphoned into a bolting cloth filter and rinsed in fresh water before being fed to the fish. The salt water was reused, but changed once weekly. Duplicate hatches were made at intervals during the experiment, and dried for 24 hours on the filter. Filter and dried nauplii were weighed, and from this weight was subtracted the dry weight of the filter, corrected for humidity at the time of weighing. Production varied with the age of the salt water used, and allowance was made for this in computing the weekly total of nauplii fed.

Dry food and *Artemia* were fed daily; whiteworms three times per week.

In removing detritus from the tanks, two to three liters of water were siphoned off and run through a bolting cloth filter. The filtered water was then returned to the tank. Weekly filtering of the water mass was accomplished by passing all of it through coarse filter paper.

Narrative of Experiment

On December 26, 1944 (Table I), two male and two female guppies, young but mature, were obtained from the Steinhart Aquarium, San Francisco. One of each sex was placed in each tank. The first brood was born in tank "A" on January 11, 1945, during the third week of the experiment, and was closely followed by a brood in tank "B." Successive broods accomplished the further growth of the populations, as can be seen by the steps in the population curve to the left of Figure 1.

During the early part of the experiment considerable difficulty was experienced in stabilizing the experimental technique, due to lack of experience in the maintenance of aquaria. As an example of this, the entire water mass of tank "A" was changed at the end of the eighth week of the experiment (Fig. 1), resulting in the death of 41 of the 44 fish. The remaining fish in the two tanks were then redistributed so that each tank had approximately equal numbers of immature, adult male and adult female fish.

During the ensuing three weeks the populations again grew until each had about 40 fish, and then both became stabilized at approximately that number. Following seven weeks of stability, the food for population B was increased 41 per cent. The increased diet did not result in a corresponding increase in population, even though it was maintained for three weeks.

TABLE I

TEMPERATURES, NUMBERS AND WEIGHTS FOR EXPERIMENTAL POPULATION OF *Lebistes reticulatus*

	Population A			Population B		
Week	Av. Temp., °C	No. of Fish	Wt. of Fish, grams	Av. Temp., °C	No. of Fish	Wt. of Fish, grams
1	24.4	2	....	23.9	2	....
2	24.2	2	....	24.8	2	....
3	25.0	15	....	24.5	19	....
4	24.6	15	....	25.4	19	....
5	24.1	15	....	26.2	19	....
6	24.5	46	....	25.3	39	....
7	25.4	46	....	25.5	39	....
8	23.9	21	....	24.6	21	....
9	25.1	38	....	26.3	21	....
10	25.1	38	....	25.6	39	....
11	25.7	38	....	26.1	41	....
12	26.6	38	....	25.8	40	....
13	25.6	40	7.71	25.0	40	6.80
14	24.2	39	8.52	25.6	40	8.25
15	25.7	..	....	25.5	..	....
16	24.9	39	8.78	24.8	39	8.24
17	25.4	39	7.78	24.6	39	9.49
18	25.2	40	9.95	24.9	39	9.90
19	25.4	39	9.85	25.3	39	11.27
20	24.6	45	11.20	25.1	46	11.44
21	24.6	54	11.12	25.0	56	13.15
22	24.6	56	13.39	25.1	67	13.40
23	24.1	58	13.18	25.0	65	14.55
24	25.5	60	13.41	25.5	65	15.90
25	26.4	67	13.96	25.9	68	16.63
26	25.2	80	14.46	24.7	82	16.03
27	25.6	78	13.95	25.4	90	16.41
28	25.3	74	13.14	25.6	87	17.80

Finally, the protection for the young fish (described under "Apparatus and Methods") was installed, and both populations started to increase, with population B reaching somewhat higher levels.

EFFECT OF SPECIFIC FACTORS

Of the factors which might influence population levels, five were considered significant: (1) light, (2) temperature, (3) water condition, (4) space, (5) food. These will now be considered separately.

That reproductive rate (and thus population level) in fish is correlated with amount of light has been demonstrated by various investigators. For instance, Turner (1937) found that in *Lebistes* the long days of summer result in a shorter interval between broods than that prevailing during the winter. Since the effect of light was not of interest in the present study, light

was held constant by placing the aquaria in a windowless room and supplying artificial light 24 hours per day.

Temperature changes of considerable magnitude would undoubtedly affect reproductive rate. To eliminate the possibility of such an effect the temperature of the water in the tanks was thermostatically controlled at approximately 25°C. (Table I).

Water condition might affect population level, and considerable effort was expended to maintain a relatively constant state in the water masses of the tanks. Oxygen content was maintained (the aquaria contained no plants) by using a conventional airstone, the stream of bubbles from it creating a circulation of the water mass and thus constantly exposing new water to the air. Large waste particles were siphoned off each day, and fine suspended material was removed each week by running the entire water mass through filter paper. To prevent accumulation of dissolved wastes, one-third of the water mass was replaced with new water at four-week intervals.

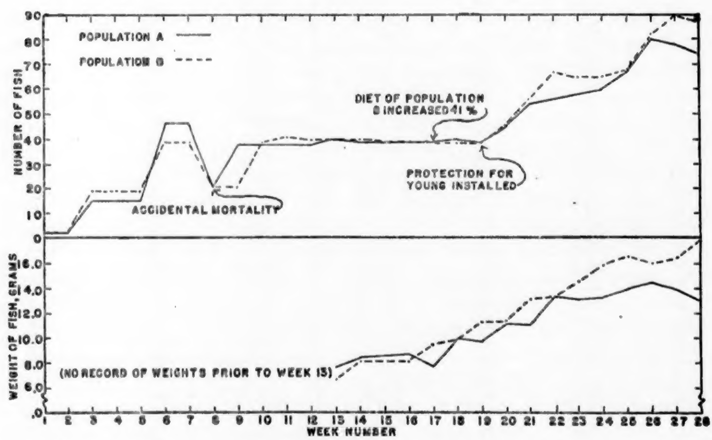

Fig. 1. Numbers and weights of fish for experimental populations of *Lebistes reticulatus*, during progress of experiment.

During the course of the experiment it became apparent that amount of space (held constant by daily replacement of water lost through evaporation) must limit population size, under the other conditions as maintained. From the 10th to the 19th week of the experiment the levels for both populations remained very close to 40 fish (Fig. 1), despite the fact that the amount of food for population B was increased 41 per cent after the 16th week. This seems a conclusive indication that, under the conditions maintained up to the 19th week, space limited the size of the populations. The mechanism of limitation, familiar to all aquarists, is the eating of the new-born young by the adult fish. The finding in the present experiment is consistent with that of Breder and Coates (1932), who found that the populations in two 6-liter

aquaria became stabilized at 9 fish each, regardless of the fact that an excess of food was always present.

Because conversion of lower order food to fish flesh is important in commercial fisheries studies, a great deal of effort was expended in an attempt to measure all food offered the fish, and to keep the amounts constant (see "Apparatus and Methods"). In Table II are shown the amounts of food

TABLE II

AMOUNTS OF FOOD PLACED IN TANKS FOR EXPERIMENTAL POPULATIONS OF *Lebistes reticulatus* (ALL UNCONSUMED FOOD REMOVED AFTER 24 HOURS)

	Population A				Population B			
Week	Dry food,§ grams	Worms,‡ grams	*Artemia*,† grams	Total, grams	Dry food,§ grams	Worms,‡ grams	*Artemia*,† grams	Total, grams
1	7.00*	.20*	..	7.20	7.00*	.20*	..	7.20
2	7.00	.60*	..	7.60	7.00	.60*	..	7.60
3	7.00	.40*	.30*	7.70	7.00	.40*	.10†	7.50
4	7.00	.30	.50*	7.80	7.00	.30	.50*	7.80
5	7.00	.55	.50*	8.05	7.00	.55	.50*	8.05
6	7.00	.60	.50*	8.10	7.00	.60	.50*	8.10
7	7.00	.90	.50*	8.40	7.00	.90	.50*	8.40
8	.70	.60	.50*	1.80	.70	.60	.50*	1.80
9	.70	.90	.50*	2.10	.70	.90	.50*	2.10
10	.70	.90	.50*	2.10	.70	.90	.50*	2.10
11	.70	1.50	.50*	2.70	.70	1.50	.50*	2.70
12	.70	1.50	.50*	2.70	.70	1.50	.50*	2.70
13	.70	1.50	.50*	2.70	.70	1.50	.50*	2.70
14	.70	1.50	.50*	2.70	.70	1.50	.50*	2.70
15	.70	1.10	.50*	2.30	.70	1.10	.50*	2.30
16	.70	.90	.50*	2.10	.75	.90	.50*	2.15
17	.70	1.50	.50	2.70	1.05	2.25	.50	3.80
18	.70	1.50	.50	2.70	1.05	2.25	.50	3.80
19	.70	1.50	.50	2.70	1.05	2.25	.50	3.80
20	.70	1.50	.50	2.70	1.05	2.25	.50	3.80
21	.70	1.50	.50	2.70	1.05	2.25	.50	3.80
22	.70	1.50	.50	2.70	1.05	2.25	.50	3.80
23	.70	1.50	.50	2.70	1.05	2.25	.50	3.80
24	.70	1.50	.50	2.70	1.05	2.25	.50	3.80
25	.70	1.50	.50	2.70	1.05	2.25	.50	3.80
26	.70	1.50	.50	2.70	1.05	2.25	.50	3.80
27	.70	1.50	.50	2.70	1.05	2.25	.50	3.80
28	.70	1.50	.50	2.70	1.05	2.25	.50	3.80

§ Dry weight of "tropical fish food" (probably ground shrimp plus some vegetable matter).
‡ Damp weight of whiteworms (*Enchytraeus albidus*); also some earthworms and dung worms during last month of experiment.
† Dry weight of newly hatched brine shrimp (*Artemia salina*) nauplii.
* Estimated.

offered during each week of the experiment. The amounts at the start of the experiment were based on general suggestions of aquarists, and were found to be too large with respect to dry food and too small with respect to live food. Accordingly, the proportions were changed somewhat until a stable diet was reached at week 11. With the exception of a lesser supply of worms during weeks 15 and 16, the diets for the two populations were kept constant and equal until week 17. At that time the amounts of dry food and worms

were increased 50 per cent for population B. The amount of encysted eggs for the *Artemia* cultures was also increased 50 per cent, but this was later found not to have resulted in a corresponding increase in the weight of nauplii produced. The actual increase in the amount of food offered thus was only 41 per cent. After week 21 all food offered was consumed, as far as could be determined from visual inspection. Prior to this, small amounts of the dry food were siphoned from the bottom of the tanks each day before new food was offered.

TABLE III

LENGTH FREQUENCIES OF EXPERIMENTAL POPULATIONS OF *Lebistes reticulatus* (SNOUT-TO BASE-OF-CAUDAL LENGTH), 4 DAYS AFTER TERMINATION OF EXPERIMENT

Length, mm.	Population A				Population B			
	Male	Female	Immature	Total	Male	Female	Immature	Total
7	.	.	5	5	.	.	8	8
8	.	.	10	10	.	.	15	15
9	.	.	3	3	.	.	4	4
10	.	.	3	3	.	.	1	1
11	.	.	5	5	.	.	1	1
12	.	.	3	3	.	.	2	2
13	.	.	3	3	.	.	3	3
14	.	.	2	2	.	.	5	5
15	.	.	.	.	.	.	2	2
16	2	.	1	3	1	.	.	1
17	1	.	.	1	.	2	.	2
18	2	.	.	2	2	1	.	3
19	2	.	.	2	6	.	.	6
20	5	.	.	5	8	.	.	8
21	1	1	.	2	3	.	.	3
22	1	1	.	2	.	.	.	.
23	.	.	.	.	.	.	.	.
24	.	4	.	4	.	.	.	.
25	2	3	.	5	1	1	.	2
26	.	1	.	1	.	1	.	1
27	.	1	.	1	.	.	.	.
28	.	1	.	1	.	4	.	4
29	.	.	.	.	.	.	.	.
30	.	5	.	5	.	4	.	4
31	.	3	.	3	.	2	.	2
32	.	.	.	.	.	3	.	3
33	.	.	.	.	.	1	.	1
34	.	.	.	.	.	1	.	1
35	.	1	.	1	.	2	.	2
Total number:	16	21	35	72	21	22	41	84
Mean Length:	19.8	27.3	9.9	17.2	19.7	28.6	9.7	17.1

When the increase of food for population B did not result in an increase in the number of fish, it was felt that the situation might be changed by providing protection for the young fish. The protection described under "Apparatus and Methods" was installed in both tanks during week 20, and

both populations began a new growth (Fig. 1). There was apparent response to the differential diets under the new conditions, for population B (with the greater diet) was consistently greater in both number and weight than population A, after week 23. Four days after the termination of the experiment, all but four of the fish in each population were killed and measured (lengths of the eight live fish were estimated). Length frequencies (Table III) were tabulated to determine if the fish of population B were significantly larger, but there is no indication that this was true. Apparently the difference between the two populations was confined to their total number, and to the average weight of the individuals.

Discussion

It is regrettable that it was necessary to terminate the experiment before stability of the population had been attained under the final conditions (protection for the young and a 41 per cent greater diet for population B). It appears, however (Fig. 1), that population A would have stabilized at about 70 fish and a weight of 13 grams, and population B at 80 fish and 17 grams. Only further experiments under identical conditions could establish the precise stability levels, but it does seem reasonably safe to conclude that population A was limited in its growth by the amount of food available.

The matter of food conversion at two different diet levels is of interest, and some information can be gleaned from the result of the present experiment. Starting with week 21, after which all food was consumed, population A increased from 11.12 grams to 13.14 grams at the end of the experiment. During the period this increase of 2.02 grams was attained, 18.9 grams of food were consumed, and the efficiency of conversion was 10.7 per cent. For population B the corresponding figures are 13.15, 17.80, 4.65, 26.6 and 17.5 per cent. These efficiency determinations are in the same order of magnitude as ones made by other investigators on other fish. For instance, Markus (1932) gave data indicating an efficiency of 23 per cent for bass fed entirely on live fish.

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United States Fish and Wildlife Service, 2725 Montlake Blvd., Seattle 2, Washington.

The Classification of the Fishes of the Genera *Bathylaco* and *Macromastax*, Possible Intermediates between the Isospondyli and the Iniomi [1]

By Albert Eide Parr

THE genus *Bathylaco* was first established by Goode and Bean (1895: 57) on the basis of a single mature, but rather damaged specimen placed by them in the family Synodontidae. Good and Bean's original classification of the genus has been followed in all subsequent references to their species down to the present time (as by Jordan, Evermann and Clark, 1930: 164), apparently without re-examination of the type. A much smaller, probably immature specimen of a closely related, perhaps identical form was described by Beebe (1933*a:* 161) as *Macromastax gymnos,* a new genus and species of the family Alepocephalidae. A second fully grown example of Goode and Bean's *Bathylaco nigricans* was found among the undetermined alepocephalids of the "Dana" collections sent to the writer for study and identification.

The striking similarity to the Synodontidae, and the even greater resemblance to some of the larger myctophids (especially of the genera *Serpa* and *Lampadena*) that caused the genus *Bathylaco* to be placed among the Iniomi, are clearly shown in Figure 1. But the features by which *Bathylaco* differs from the Iniomi and approaches the Isospondyli seem basically more significant. Until more satisfactory material of these interesting intermediate forms is obtained, and our knowledge of the morphology of the Isospondyli, particularly the Alepocephalidae, becomes more adequate, the new family Bathylaconidae is tentatively placed among the Isospondyli in spite of rather strong, but unfortunately incomplete, indications that a new order, which might be called the Bathylaconi, would be more appropriate.

The deficiencies of the material will be fully described under the species. At this point I shall merely discuss the significance of the features which can be observed or reasonably inferred from the available evidence.

Functionally, the morphology of *Bathylaco* is obviously in much better accord with that of the Synodontidae than with any deep-sea isospondylid. The structure of the upper jaws is of particular interest, in that it represents a striking case of evolutionary convergence of heterologous parts. In *Bathylaco,* as in *Synodus, Saurida* and in many other Iniomi, the upper margin of the mouth, which is tooth-bearing throughout its length, is formed by a long, straight and rather narrow, but thickened and very strong bone, with a straight, or gently concave ventral profile. Except at the anterior end, it is hard to distinguish this jawbone of *Bathylaco* from the jawbones of similar Iniomi. But in the Iniomi it is the premaxillaries that form this bone; while the maxillaries are excluded from the margin of the mouth and are generally modified into a semi-hollow sheet, closely applied to the premaxillaries in the genera in which the jaws and the gape take the form here described. In *Bathylaco* it is the maxillary that has developed the functional form of the premaxillaries of the Synodontidae, with the premaxillaries

[1] Papers from the "Dana" Oceanographical Collections, No. 29.

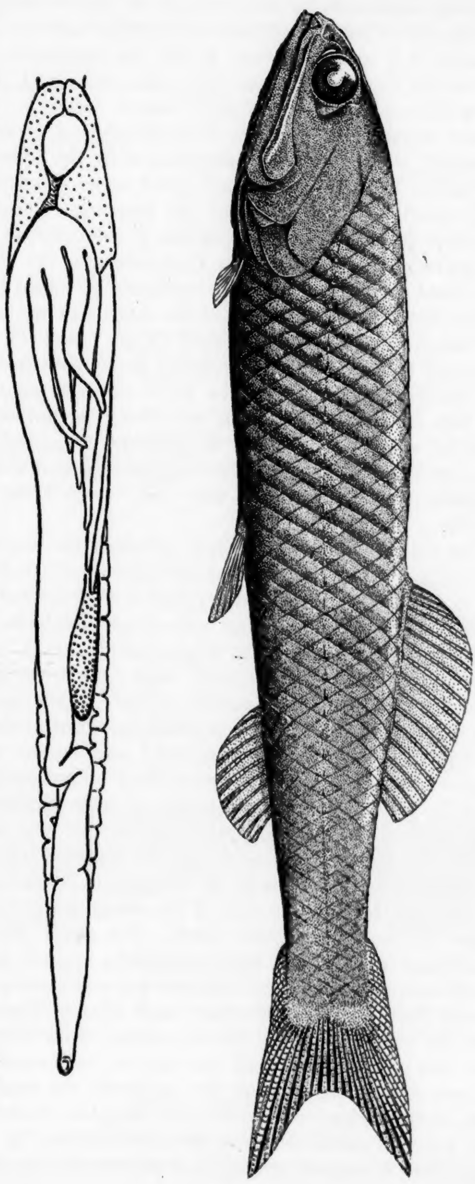

Fig. 1. Above: *Bathylaco nigricans* Goode and Bean 215 mm. in standard length, specimen by P. Talephorus. Below: Ventral view of abdominal organs.

apparently confined to a narrow space at the tip of the snout. Among the deep-sea Isospondyli a very large gape, with the upper margin formed mainly by tooth-bearing maxillaries, is also common in the Alepocephalidae; but the long maxillaries in these forms are not straight, narrow, and somewhat compressed rods of a spongy texture, as are the maxillaries of *Bathylaco* and the premaxillaries of the Iniomi, but wide, thin, hard, and bladelike, with a convex instead of a gently concave ventral outline.

The general development of body musculature and intestinal tract in *Bathylaco* further strengthens the agreement with the Synodontidae. In the Alepocephalidae the writer has always found only a short stomach ending rather bluntly a short distance beyond the insertion of the pyloric arm, which thus arises from the posterior portion of the ventricle. The pyloric appendages are small to moderate. In *Bathylaco* and the Synodontidae a long, strong-walled caecum of the ventricle extends backward far beyond the pyloric arm to form a separate division of the entire stomach, usually as long as, or even longer than the anterior part (Figs. 1 and 2). Both in the Synodontidae and in *Bathylaco* we also find a strong development of pyloric appendages, much beyond anything the writer has seen among the Alepocephalidae. But in *Synodus, Saurida,* etc., this phenomenon is primarily characterized by a great increase in the number of appendages, while in *Bathylaco* it results only from the greatly increased size of a relatively small number of caeca, which, apart from their size, would agree well with the Alepocephalidae.

Finally the entire body of *Bathylaco,* including the ventral, abdominal wall, shows a thickness and firmness of musculature which is very unusual among deep-sea fishes, but particularly typical of the Synodontidae.

From these observations we may undoubtedly at least conclude that *Bathylaco* must be leading the life of a synodontid, that is, of a fast swimming, voracious predator, and that there must be a functional correlation between mouth parts, ventricular caecum, pyloric appendages and general musculature suitable for such a life. Whether the form of the stomach can be entirely explained merely as a functional modification seems open to doubt, however, since even such large-mouthed alepocephalids as *Bathytroctes* retain the short stomach characteristic of their family.

The stage of evolution of the upper branchiostegal rays of *Bathylaco* is very primitive even for the Isospondyli, and far removed from the condition among the Iniomi, where the rays do not participate in the formation of the outer gill cover, and as many as four of the upper branchiostegals may be firmly hidden under the opercular bones. The upper branchiostegal of *Bathylaco* (Figs. 1 and 2) is a wide, completely exposed lamella with its upper edge joining the lower contours of sub– and interoperculum. It is actually larger than the interoperculum, and plays a greater rôle in the formation of the outer gill cover. The second and third branchiostegals are also more or less broadened, and all the rays are fully exposed.

On the basis of homologies rather than analogies, the small premaxillaries and the long, tooth-bearing maxillaries would also place *Bathylaco* among the Isospondyli; but this classification is again contradicted by the absence of mesocoracoids, which suggests shifting *Bathylaco* away from the Isospondyli

towards the Iniomi. When we add to these conflicting indications luminous organs which show definite affinities both with those of the Alepocephalidae and those of the Iniomi, the reasons for regarding the Bathylaconidae as a possible intermediate between the Isospondyli and the Iniomi become plain.

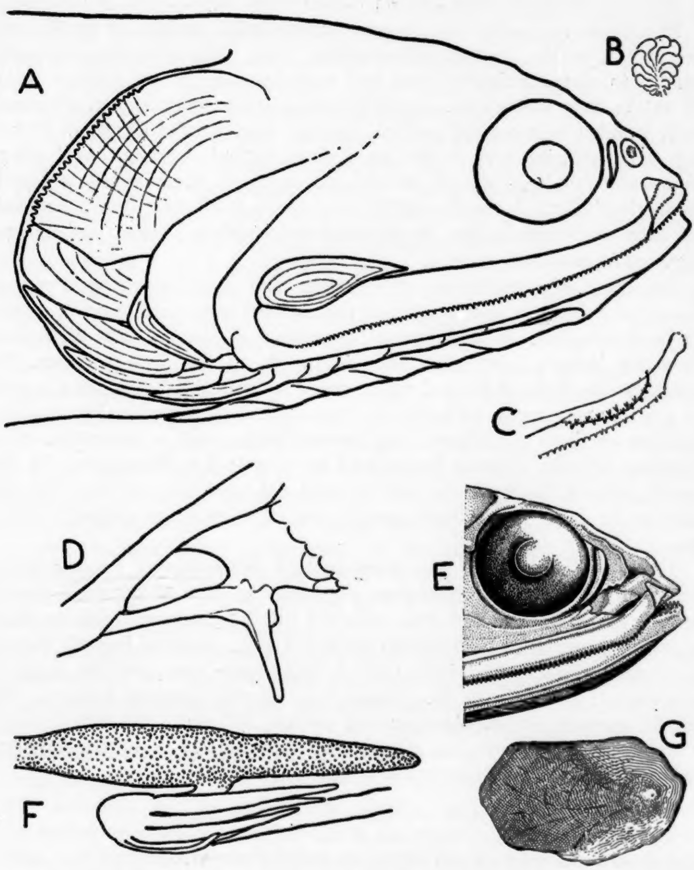

Fig. 2. *Bathylaco nigricans*. A.—Superficially dissected lateral view of head of "Dana" specimen with reconstruction of premaxillary. B.—Nasal organ. C.—Palatine dentition viewed through maxillaries. D.—Scapula and coracoid. E.—Head of type specimen with premaxillary fragment. F.—Stomach and pyloric appendages. G.—Scale from lower edge of shoulder girdle.

Order Isospondyli

Family Bathylaconidae

Mouth wide, tooth bearing maxillaries forming the larger part of their

upper margin. Upper branchiostegals broad and exposed, participating in the formation of the outer gill cover. Mesocoracoids absent. Posttemporal forked. Stomach with a long ventricular caecum. No adipose fin.

Genus *Bathylaco* Goode and Bean

Bathylaco, Goode and Bean, 1895:57; ? *Macromastax* Beebe, 1933*a:* 161; 1933*b:* 80.

Maxillaries somewhat compressed, rod-like, with straight or gently concave ventral profile. Supramaxillary single, large. Premaxillaries very small, confined to snout. Palatines thick and tooth-bearing. Vomer without teeth. Gill rakers large and widest. Coracoid with rod-like ventral spur. Pectorals small, inserted near ventral profile. Ventrals near middle of body. Dorsal long, with wide-set rays, beginning a little behind ventrals. Anal short, origin under middle of dorsal; its end approximately opposite end of dorsal. Caudal deeply forked. Body slightly compressed, fusiform, strongly muscled, with large deciduous scales. Head moderate, scaleless. Pyloric appendages large, but in moderate number.

The state of preservation of the type and only known specimen of *Macromastax gymnos* Beebe (1933*a:* 162, fig. 40) is so poor that few details can be determined. In addition to the general similarities with *Bathylaco* shown by Beebe's description and illustration of the first specimen, the disintegration of the abdominal wall permits us to establish that the shape of the stomach also agrees with that of *Bathylaco.* Beebe specifically mentions dentition on both maxillaries and premaxillaries, and a suggestion of a boundary between the two bones may be seen in his illustration. In the present state of the type, the writer would not venture to differentiate the bones of the upper jaw without staining, but relies upon the original description.

There can scarcely be any question that *Macromastax gymnos* is extremely closely related to *Bathylaco nigricans.* In view of the small size of the type of *M. gymnos* (35 mm., standard length) compared with the large size of the material of *B. nigricans* (209–215 mm., standard length) it even seems quite possible that both the relatively large eyes and the reported nakedness of the body in *M. gymnos* may be only juvenile features, and that *M. gymnos* and *B. nigricans* may actually belong to the same species. In any event, the justification of retaining *Macromastax* as a separate genus must depend upon the discovery of a scaleless adult.

Bathylaco nigricans Goode and Bean

Bathylaco nigricans Goode and Bean, 1895:57, fig. 79.
? *Macromastax gymnos* Beebe 1933*a:* 162, fig 40; 1933*b:* 81, fig. 22.

Head bullet-shaped, with short, blunt snout and almost circular cross section. Body sub-cylindrical anteriorly, thick, but deeper than wide posteriorly.

Gape very long, eyes above its anterior half. Maxillary with a single but rather irregular series of teeth throughout its length. Premaxillaries small, their dentition unknown. Palatines with a group of teeth 1–3 rows wide (Fig. 2C). No teeth on vomer or tongue. Lower jaw with irregular band of teeth 3–4 rows wide, the largest teeth inside.

Both premaxillaries of the "Dana" specimen are completely lost, with the

snout rubbed to the bone. The ascending processes of both premaxillaries are present in the type, but the lower, presumably tooth-bearing, parts are raggedly torn away as shown in Figure 2.

Head with scattered groups of minute club-shaped organs rising from the skin, particularly in the region at the top of the gill cover. These organs are presumably luminous and seem entirely identical with those found over the entire body in such alepocephalids as *Photostylus,* and others. There is also a fairly large comma-shaped preorbital luminous organ, similar to that of many stomiatoids and myctophids, rather than the small circular organs sometimes found in this position among alepocephalids.

The following figures give the writer's own measurements and counts of the type, Museum of Comparative Zoology No. 28061 (in parenthesis, with a capital T) and of the "Dana" specimen (not yet catalogued).

Standard length 215 mm. (T. 209). Proportions in per cent of standard length: Head 27 (T. 25.6). Eye 5.0 (T. 5.0). Snout 4.4 (T. 3.6). Interorbital width 4.7 (T. 4.4). Greatest width of skull 11.2 (T. 10.2). Upper jaw 18.1 (T. 17.5). Lower jaw 18.8 (T. 18.5). Supramaxillary 6.3 (T. 6.4). Snout to top of gill slit 17.4 (T. 17.3). Greatest depth 18.1 (T. about 14, shrunken). Depth of caudal peduncle 8.4 (T. about 8). Snout to dorsal fin 57.8 (T. 53.2). Snout to ventrals 53.5 (T. 54.4). Snout to anal 70.2 (T. 71.3). Base of dorsal 22.5 (T. 27.5). Base of anal 10.7 (T. 11.7). Length of pectorals 5.4. Length of ventrals 8.8. Longest ray of caudal 18.1. Longest ray of anal 7. Longest gillraker 3.4. Length of preorbital organ 1.9 (T. 2.0). Length of upper branchiostegal 7.0. Width of upper Br. 1.85. Longest pyloric caecum 13.5. Shortest pylor. caec. 8.9. Posterior length of stomach from crotch of pyloric arm 16.3; from behind pyloric arm 13.7.

Scales in longitudinal series about 46. Scales between ll. and dorsal fin 4; between ll. and anal 5. D. 18 1/2 (22 1/2 in T.). A. 11 1/2 (12 1/2 in T). P. 7/6 (6? in T.). V. 6/7 (8 in T.). Br. 8 (9 in T.). Gill rakers 4-1-8 (4-0-7 in T.). Pyloric caeca 7.

These measurements and counts show that the type generally has a higher number of rays, including branchiostegals. The greatest difference is in the dorsal fin count, and this is also reflected in the length of the fin base. But in view of the absence of any other significant difference it seems preferable at this point to avoid the introduction of a new species.

An unusually wide spacing of the middle dorsal rays is characteristic of both specimens, and so is the long, rod-like, ventral spur of the coracoid. The writer has found no postcleithra in the region of the pectoral fins themselves, but has not explored behind the upper shoulder girdle. The coracoid spur would seem to have some of the functions of a lower postcleithrum.

The "Dana" specimen was taken in the Pacific off Colombia, 6°48'N. 8°33'W. with 3,500 meters of wire out. The type, "off Santa Cruz," according to Goode and Bean, in the Gulf of Mexico *fide* Jordan, Evermann and Clark (1930). The writer has been unable to find this location or to verify the locality reference. The geographic difference might increase or reduce the significance of the differences in the counts, according to one's point of view. It seems wise to await the capture of more specimens, before reaching any conclusions on this point.

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Observations on the Nidamental Glands of *Hydrolagus colliei, Raja rhina* and *Platyrhinoidis triseriatus* [1]

By R. RAGHU PRASAD

A STUDY of the reproductive system and the nature of the reproduction of the elasmobranchs was started by me in 1940, with the idea of finding out whether or not there is any correlation between the phylogeny and the reproductive structures and habits. Emphasis was laid on such factors as oviparity, ovoviviparity and viviparity and the consequent structural modifications in the nidamental glands; but, owing to many reasons, it was not possible to gather enough data to draw any definite final conclusions. It was, therefore, thought that observations made whenever material was available could be published intermittently and final conclusions drawn at a later time.

My previous investigations were exclusively on Indian species. Having now had an opportunity to examine some of the Pacific species, it seems advisable to report on these forms. This work is a continuation of my papers on "The structure, phylogenetic significance, and function of the nidamental glands of some elasmobranchs of the Madras coast" and "Further observations on the nidamental glands of a few elasmobranchs" (see "Literature Cited").

[1] I should like to take this opportunity to express my sincere thanks to Mr. Nathan W. Riser for the help he rendered in collecting the material.

The material for the study includes *Hydrolagus colliei, Raja rhina* and *Platyrhinoidis triseriatus.* It was collected from San Luis Obispo and Monterey Bay. The nidamental glands were fixed in Bouin's fluid and Zenker's fluid. Sections of the glands were stained with Heidenhain's iron haemotoxylin, Heidenhain's Azan stain, Mallory's triple stain, and Hoyer's thionin blue.

Hydrolagus colliei (Lay and Bennett), belonging to the family Chimaeridae, is oviparous. The nidamental glands are well developed and in a specimen 580 mm. in length these glands measured 39 mm. x 21 mm. (Fig. 1). In the fresh condition each gland shows externally an anterior flesh-colored region which is the albumen-secreting zone and a broad cream-colored band which is the shell-secreting region. There is a single central lumen in each of the glands which is continuous with the lumina of the cranial and caudal oviducts.

When the gland is slit open the inner surface of the first region, that externally has the flesh color, is seen to be traversed by shallow grooves. These are the cranial transverse bands. The anterior region of the second zone possesses the true lamellae, whereas the rest of the gland is characterized by the caudal transverse bands (Prasad, 1945: 285–287).

A longitudinal section of the entire gland shows anteriorly the albumen-secreting region followed by a very narrow zone of two or three rows of tubules. These are the mucus-secreting glands that resemble in position and structure those described by Nalini (1940) in *Chiloscyllium griseum.* The shell-secreting region follows next. This region displays different shades of red when treated with Mallory's triple stain. Four distinct regions could be made out. The first 19 to 20 rows of tubules stain light red, and this band is followed by a dark red region which is slightly longer than the preceding zone. A third region, the longest of all, stains just like the first band; and, lastly, there is the dark red zone of the same depth of color as the second region. A number of tubules of the last shell-secreting zone apparently function as mucus-secreting glands, since they are identical in appearance to the anterior mucus-secreting tubules. These are concentrated toward the lumen of the gland. The same phenomenon has been observed in *C. griseum* by Nalini (*op. cit.*).

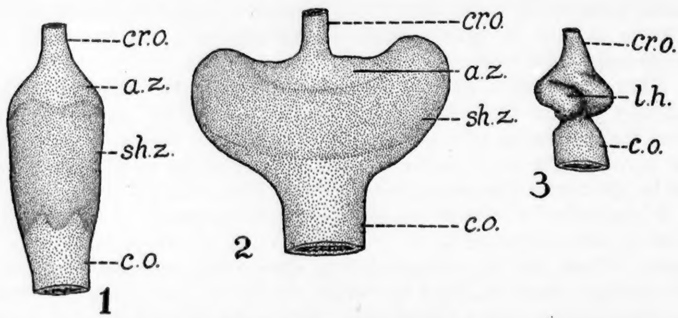
The albumen-secreting tubules, as already mentioned, open between the cranial transverse bands, whereas the shell-secreting tubules open in the region of the lamellae. The posterior mucus-secreting tubules open in the region of the caudal transverse bands. The structure and the histology of the cranial transverse bands, lamellae, caudal transverse bands and the tubules secreting albumen, mucus and the shell material have been described in other forms; and, since there are no important differences in the present species, a description of the histology is superfluous. The secretory activity of the three glandular tissues is extremely pronounced, as indicated by the granules in the cells.

The nidamental glands of *Hydrolagus colliei* thus exhibit all of the three zones: the albumen- the mucus- and the shell-secreting zones.

Raja rhina Jordan and Gilbert, the long nosed skate, belonging to the family Rajidae, is oviparous; and has the nidamental glands rather well developed, measuring 27 mm. along the longitudinal axis and 57 mm. across

in a specimen 600 mm. long (Fig. 2). When fresh, the glands externally show two distinct regions, viz., the anterior, flesh-colored, albumen-secreting zone, followed by the shell-secreting region which is distinguished by its light yellow color. There is a spacious central lumen.

The inner aspect of the gland shows, in the anterior, albumen-secreting region, the cranial transverse bands which, from a surface view, appear as shallow grooves. The anterior half of the shell-secreting zone is characterized by the lamellae, which are 35–40 in number. The remaining portion of the shell-secreting region possesses the caudal transverse bands.



Figs. 1–3. Nidamental glands of *Hydrolagus colliei*, *Raja rhina*, and *Platyrhinoidis triseriatus*, respectively.

a. z., albumen-secreting zone; c. o., caudal oviduct; cr. o., cranial oviduct; l. h., lateral diverticulum; and sh. z., shell-secreting zone. All the figures are two-thirds natural size.

An examination of the longitudinal section of the gland reveals the first albumen-secreting zone corresponding to the flesh-colored region mentioned above. The shell-secreting region is not demarcated into different zones. Sections treated with Mallory's triple stain show only one zone of almost uniform bright red color. This is the region that has the yellow color when the gland is fresh. As in *Hydrolagus colliei*, there are tubules at the posterior end of the shell-secreting region which function as the mucus-secreting glands, but they are comparatively few in number. These tubules open between the caudal transverse bands.

There is no peculiarity in the histological make-up of the glandular tissue.

One of the specimens of *Raja rhina* had an egg-case containing an egg in the left uterus; and, as was to be expected, the nidamental glands contained spermatozoa.

Platyrhinoidis triseriatus (Jordan and Gilbert), the thornback, belongs to the guitar fish family, Rhinobatidae, and is ovo-viviparous. The nidamental glands of this fish are much smaller than in the other two species described in this paper. In a specimen 750 mm. in length, the nidamental glands measured 17 mm. across and 13 mm. along the longitudinal axis. They were of a uniform flesh color. Each gland consists of a central portion giving off two slightly twisted diverticula, one on each side of the oviduct, which extend caudad. The central region of the gland has a lumen into which the lumina of the lateral diverticula open.

A longitudinal section of the gland shows two clearly differentiated regions, a long anterior albumen-secreting zone which occupies more than two-thirds of the entire gland, and a narrow posterior band composed of 24–26 rows of tubules which is the shell-secreting zone. A careful examination of the latter region reveals that the first few tubules, seven to eight rows, stain much darker than the rest of the shell-secreting tubules.

The albumen-secreting tubules open in the region of the cranial transverse bands, which are very similar to those of the other forms studied except that they are much taller. The shell-secreting region being narrow and composed of few rows of tubules, the lamellae of this region are also consequently few. There are eight to ten rows of lamellae bearing a close resemblance to those of other species investigated.

The structure of the nidamental glands of this species is thus similar to that of other ovoviviparous forms described, the mucus-secreting glands being completely absent.

The three species reported on in this paper form an interesting series in that the nidamental glands of *Hydrolagus colliei* exhibit a structure very similar to that of a typical oviparous elasmobranch; the nidamental glands of *Platyrhinoidis triseriatus* are typical of any other ovo-viviparous species, whereas those of *Raja rhina* are intermediate in structure. In all of the oviparous forms studied till now, the narrow band of mucus-secreting tubules between the albumen-secreting and the shell-secreting zones is characteristic, whereas in the typical gland of the ovo-viviparous species like *Rhinobatus granulatus* (Prasad, 1945) the mucus-secreting glands are entirely unrepresented. The nidamental glands of *R. rhina* show certain characters that are not observed in those of other oviparous forms. In *R. rhina* the intermediate mucus-secreting tubules are completely absent, while, at the same time, mucus-secreting tubules are present in the caudal region of the gland. Thus the nidamental glands of this species exhibit an intermediate stage between the typical gland structure of the oviparous species with the mucus-secreting tubules occurring between the albumen and the shell-secreting zones, as well as at the posterior end of the nidamental gland, and the typical ovo-viviparous forms where the mucus-secreting glands are entirely unrepresented. In this species the anterior mucus-secreting tubules have disappeared while the posterior ones are still present.

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Some Possible Uses of X-rays in Ichthyology and Fishery Research

By William A. Gosline

FOR many years it has been known that X-rays, or roentgen rays, will give excellent results in depicting the bony structure of fishes, particularly the axial skeleton. But for technological and financial reasons radiology has never been widely used in ichthyological or fishery work. However, the application of roentgen rays to these fields seems to offer possibilities that far outweigh the initial difficulties in employing the technique. Some of the aspects in which X-rays may be used to advantage, and what appear to be their limitations, are outlined below.

Radiography has been used in paleontological work rather extensively by the Germans. Some of the results obtained have been superb, while others have been disappointing. The applicability of the method depends among other things upon the comparative density and upon the thickness of the matrix and of the fossil. Excellent results have been obtained with certain types of material by Peyer and reference should be made to his 1934 paper on the application of the technique to fossil material in general. The method is being applied to paleontological work in this country at the present time by Dr. Zangerl, of the Chicago Natural History Museum.

Turning to living fishes, the higher classification of these is based to a large extent, as is well known, on comparative osteology. This has meant that any work on the family level or above necessitated access to a skeleton collection. Such a collection takes time and effort to build up, and few museums have one. Furthermore, when fishes are skeletonized, the soft parts are lost along with many of the smaller bones, and unless great care is taken the relative positions of many of the parts no longer can be determined. Also, if insects are employed to clean the skeletons, fresh fishes should be used.

Another method of osteological work is that of clearing and staining. This process has been employed in recent years, particularly by Hollister (see 1934 for technique). The difficulties here are that the process is tedious, the soft parts again are lost for all practical purposes, and the specimens must be kept thereafter in glycerin. Because of the various limitations of this technique, clearing and staining can advantageously be applied only to quite small specimens.

The use of radiography might by-pass some of these difficulties. X-rays of a group of fishes would appear to give an indication of which fishes in the group showed osteological differences. The process of skeletonization could then be applied to those forms showing such differences. In this way time and effort would not have to be expended on skeletonizing a whole series of fishes, many of which might show nothing in particular. However, upon examination of the head bones in roentgenograms of a few fishes, it became obvious that there were so many overlapping bones as to make the whole head structure confusing at first glance. Nevertheless, with a little practice

differences in the osteology of the heads of various fishes could probably be detected. In this regard it might be brought out that the head bones in an ordinary fish fossil, which usually present the same problem of overlapping, are quite comprehensible to a paleontologist. Furthermore, the spectroscopic methods now so widely used in chest X-rays might well be applied.

However, both very large and very small specimens present certain difficulties for osteological work by the roentgen ray technique. For technical reasons the bones in fishes smaller than about 1 inch long do not show up well in radiographs, and some staining technique, such as that recently used by Tåning (1944: 13), might better be employed. Very large specimens, on the other hand, though they give excellent radiographs, become rather expensive to handle by this method. Yet there is one category of material on which no method other than X-rays can be employed for osteological work. This is the type, or very rare, specimen. On such material the X-ray alone does not injure or alter the specimen.

But in addition to a knowledge of comparative anatomy, a roentgenogram makes available for fish classification a meristic character not otherwise easily accessible, namely the number of vertebrae. Vertebral counts have been long but sporadically used in systematic ichthyology. Such counts, generally based on a few specimens in a skeleton collection, are often used as taxonomic characters for families and higher categories. Again, they are often employed in racial work. But in general the vertebral number is not used at the specific or generic levels. Perhaps at these levels it is thought to be nearly constant, hence valueless as a taxonomic character, but I have certainly not found it so. For example, two specimens of *Ameiurus melas melas*, the northern black bullhead, were found to differ by 10 and 8 vertebrae respectively from specimens of *Ictalurus lacustris punctatus*, the southern channel catfish, and *Ictalurus furcatus*, the blue cat. In the darters (Etheostomatinae), enough roentgenograms have been examined to verify the considerable variation in vertebral counts given by Jordan and Eigenmann (1885).

At the taxonomic levels between the race and the species, two examples, for which the data are of a very preliminary sort, may be presented for what they are worth.

In the minnow *Notemigonus crysoleucas*, vertebral counts (not including the fused vertebrae in the Weberian apparatus) were made on samples of about 15 specimens each from six states. The samples from Texas and Kansas gave averages of 32.7 and 33.0 vertebrae respectively; counts for samples from Florida, Wisconsin, and Ontario ranged from 33.6 to 33.8; that for Maine was 35.0. Thus the gradient, if it is a gradient, rises from southwest to northeast. This contrasts sharply to the cline in the number of anal fin rays for the species, which descends from southeast to northwest (Schultz, 1927).

The darter *Percina caprodes* presents a different but equally disconcerting picture. The highest count so far obtained is from Tennessee, 44.6, and the lowest from Iowa, 41.6. Intermediate counts were found in samples from Ontario, Michigan, Wisconsin, Indiana, Arkansas, and Alabama.

Previous work with marine fishes had indicated a cline in vertebral counts

correlated with temperature change, but this does not seem to hold here, at least for *Percina.* On the other hand, enough specimens have not yet been checked to tell whether vertebral number in North American fresh-water fishes changes abruptly at certain geographic boundaries, i.e., those between subspecies. Also the remote possibility exists that different Michigan populations of *Percina,* for example, show as much variation in vertebral number as among populations in different states. Though these problems remain unsolved, it may be said that the vertebral count gives every indication of being at least as important as other meristic characters in the lower levels of ichthyological classification. The use of X-rays gives for the first time a rapid method for getting at this character without damaging the specimen.

In fisheries work the vertebrae have often been used as a method of distinguishing races. It may be that for small fishes, at least, roentgenograms may prove a better method of obtaining these counts than the techniques of maceration, etc., that are at present employed.

Lastly it may be worth pointing out two phases of fish physiology to which roentgenograms have been, or might well be, applied. In some radiographs that have already been taken the intestines stand out sharply. The possibility suggests itself of studying digestive processes by feeding fishes substances which will show up on the X-ray films, as is so commonly done with humans. Second, Dr. R. C. Ball has kindly called my attention to a paper in which radiograms have been used in studying the physiology of the air bladder (Guyénot and Plattner, 1939).[1] Incidentally, in this paper living fishes have been X-rayed.

In closing I would like to take up briefly the costs and operating procedure for the X-ray apparatus, because these are the factors which seem to have kept the method from general use until now. At Michigan the Museum of Zoology has recently purchased an ordinary hospital bed-side unit. This seems quite satisfactory for ichthyological purposes. Almost any unit of the type would probably be equally applicable, provided it permits a fairly wide range of kilovoltage. (The kilovoltage we use in working with small fishes is about that ordinarily used in hospitals for X-raying the hand, and is far lower than that used in chest radiographs, for example.) We have made no modifications whatsoever on the unit as we bought it. The price new of a set such as ours is about $1300. However, ours was purchased second-hand from the War Assets Administration for $65. This admittedly is a bargain. But Professor Sherman at the University of Florida, with the aid of an old transformer that was to have been discarded and a certain amount of engineering help, was able to put one together for about $100. Films cost 35 to 40 cents for a sheet 17x7 inches, and it may be possible to bring this cost down by using photographic rather than X-ray film. But even on a 17x7-inch film roentgenograms of 50 three-inch fish may be taken at one time with a resultant cost of less than one cent a fish. Developing is done in an ordinary dark room with the help of two pans, cold water, and some inexpensive developer and hypo. The whole procedure is extremely simple once the

[1] The structure of the air bladder, though depicted strikingly in radiographs of living fishes (see Guyénot and Plattner), does not appear well in the roentgenograms I have taken of preserved specimens. This is apparently because, in preserved material, the air bladder has become filled with fluid of about the same density as the body.

apparatus has been put into operation. With care the unit is said to last almost indefinitely. The danger from the radiation can be avoided by staying out of direct line of the X-ray and by placing lead plating between the operator and the subject. Films, incidentally, must be even more carefully protected. As to time, R. M. Bailey and I have taken X-rays of over 900 specimens from over 90 different lots of fishes in about a day and a half, while 700 specimens of one lot reported on in an earlier paper (Gosline, 1947) were previously X-rayed for me at the hospital in five hours.

Though in looking back on the procedure, it all seems inexpensive and simple, admittedly it took us a year to get our apparatus and put it into operation. Furthermore, I should not be presenting this paper except for the help of various members of the University. Professor A. D. Moore, of the College of Engineering, has aided greatly in getting our equipment; Dr. L. A. Poznak, of the University of Michigan Hospital, has helped inestimably in getting our unit into operation; and Miss Zeile, of the University Health Service, has been most kind in suggesting techniques for adapting radiology to fish work. Perhaps the application of the X-ray method to ichthyological work is really more complex than I have made out. If so, my over-enthusiasm arises from the sincere belief that X-rays have great possibilities in that field.

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Ichthyological Notes

A NEW MOUNTING MEDIUM FOR FISH SCALES.—The commonly used methods of making permanent mounts of fish scales are not wholly satisfactory. By adopting a modification of a water soluble medium used by Sayre (1941, The Bryologist, 44) for mounting mosses, we have a quick and easy method of obtaining permanent slides which do not check or become opaque with age.

After soaking dried scales for a few minutes in water (or using fresh scales), they may be placed directly into a drop of mounting medium on the slide, and a cover slip applied and weighted if necessary . The slides are dry enough to put away after 24 hours at room temperature. The cover slips may easily be removed at any time by soaking the slides in warm water.

This method of mounting scales has been used on a mass production basis and after a year the slides remain unchanged with no sign of opacity or checking. Preparation of the medium involves 100 gm. of gum arabic in 250 cc. of distilled water (50 cc. less water than in the original formula since the medium used for mosses is too thin for use with scales); let stand until the gum arabic is in suspension, then force-filter through coarse paper; add 40 cc. glycerine and 20 cc. of 40 per cent formalin.

According to the original work of Sayre, the amount of glycerine to be used depends upon the climate. Too little glycerine produces checked edges. Colorado climate takes 12 cc. of glycerine per each 20 gm. of gum arabic used, while our experience shows 8 cc. of glycerine per each 20 gm. of gum arabic to be sufficient.—DELTA E. UPHOFF, *Department of Zoology, University of Rochester, Rochester, New York.*

A NOTE ON THE MOVEMENT OF THE PIKE, *ESOX LUCIUS*.—An experiment in the reduction of the pike, *Esox lucius*, at Square Lake, Alberta, was begun in May, 1947. The parts of the lake where the pike spawn were treated with rotenone in the hope that, at this time of year, when the pike are in shallow water, other species of fish would escape the poison. As a preliminary to applying the poison, net fishing was carried out on the three spawning grounds in the lake and the pike caught were marked by clipping a fin and then liberated. After the poisoning it was hoped that the ratio of marked to unmarked fish recovered would enable us to calculate the total pike population.

The pike caught on each spawning ground were differently marked so that we could tell, on recovery of a marked fish, at which spawning area it had been marked. It is the movements of these marked fish that I wish to report in this paper.

Square Lake is about 3 miles long and 1.5 to 2 miles wide. The three spawning areas, designated 1, 2 and 3, are well separated; 1 and 2 are 1.5 miles apart, each at the end of a long bay on the south shore of the lake; and 3 is on the north shore of the lake, 2 miles from each of the others.

Marking of fish was begun on May 6 in area 1; by May 9, 239 pike had been marked by clipping the left pectoral fin. On May 10 a net, set for the first time in area 2, yielded 49 fish, of which one had been marked in area 1.

On May 11 a catch of 48 fish in area 2 contained three which had been marked in area 1. On May 15 a catch of 25 fish from area 2 contained seven which had been marked in area 1. These fish caught in area 2 were marked by clipping the left pelvic fin.

On May 14, a net lifted for the first time in area 3, on the north shore, yielded 83 fish of which two had been marked in area 2 and one in area 1.

On May 16, of nine pike caught in area 1, one had been marked in area 2.

Thus within 10 days (May 6-16th) the pike had moved around the whole lake, visiting the three widely separated spawning grounds.

One might suppose that the spawning grounds, particularly when separated by 1.5-2 miles of open water, would have separate populations of spawning fish. Our findings show definitely that instead, during spawning, the pike "shop around" from one spawning area to another.—R. B. MILLER, *Department of Zoology, University of Alberta, Edmonton, Alberta, Canada.*

UNUSUAL ITEMS IN THE DIET OF THE NORTHERN MUSKELLUNGE (*ESOX MASQUINONGY IMMACULATUS*).[1]—This is the record of the occurrence of a muskrat and a grebe in the stomach of a northern muskellunge. On a visit to northern Wisconsin during the fall of 1946, the author learned that Arnold Blankenburg of Butternut, Wisconsin, had caught a 50.5-inch, 43.5-pound musky in Butternut Lake. This fish took eighth prize for muskellunge caught during 1946, in the Field and Stream (March, 1947: 86) fishing contest. In an interview Mr. Blankenburg gave the following information: The musky was caught by casting a "Gentleman Jim" lure, on September 6, 1946, at 6:00 P.M., just after a thunder shower. The fish had been lying on a shoal about 4 feet deep, and about 20 feet from a heavily wooded shore. It, a female, was in excellent condition, with sound teeth, and with no external evidence of physical injury. The stomach of the muskellunge was opened by a Mr. Czarnizski, taxidermist of Medford, Wisconsin, in the presence of Mr. Blankenburg; it contained a partly digested, medium-sized muskrat (*Ondatra z. zibethica*) and a freshly swallowed pied-billed grebe (*Podilymbus p. podiceps*).

The voracity and predaceous tendencies of the muskellunge have been observed on several occasions by the author. Upon examination of stomach contents, various items of aquatic fauna have been found such as large walleyes, suckers, perch, minnows, and frogs. In the literature are reports of investigators observing muskellunge feeding on young birds and young muskrats, swimming at the surface of waters. However, in a cursory examination of the literature the writer found no records of mammals or birds being recovered from stomachs of this fish.—LELAND R. ANDERSON, *Michigan Department of Conservation, Watersmeet, Michigan.*

[1] Contribution from the Institute for Fisheries Research, Michigan Department of Conservation.

NOTROPIS PERPALLIDUS HUBBS AND BLACK IN OKLAHOMA.[1]—The discovery of this very interesting minnow in Oklahoma came as a complete surprise since only two specimens, the holotype and one paratype (Hubbs and Black, COPEIA, 1940, 1:47), were previously known. The type locality (Saline River, 5 miles north of Warren, Bradley County, Arkansas) is about 135 air miles east southeast of Beaver's Bend State Park in Oklahoma, where our single specimen was taken below the dam on Mountain Fork River, tributary of Little River, tributary of the Red River, on June 6, 1947.

The specimen was not noticed in the field and consequently there is some uncertainty concerning the habitat. However, our operations were largely confined to two different habitats: the immediate vicinity of the spillway, and a small area of clear, quiet, shallow water with a mud bottom through which large boulders projected. Farther downstream the banks were so steep and slippery we were unable to work. Other minnows taken at the same station are as follows: *Notropis boops, N. whipplii,* and *N. atherinoides.*

The Oklahoma specimen is 33 mm. long and is in agreement with either the holotype or the paratype or both in most respects or intermediate between them. In the following characters this specimen differs from the types as indicated in parentheses, the holotype being listed first where differing from the paratype: body depth 1.6 (1.7) times greatest width; caudal peduncle 1.0 (1.2) in head; length of snout 3.7 (3.8, 4.0) in head; eye 3.0 (3.2, 3.1) in head, and slightly greater than the bony interorbital width (= this distance); anal rays 9 (11, 10); pelvic rays 8-9 (9-9); scales 6-34-4 (7-34-4, 6-36-4). The melanophores are arranged in quite the same manner as described by Hubbs and Black for the types except that there is a single instead of a double series of melanophores behind the anal fin. The melanophores of the frontal region are apparently more numerous, forming a rather dense pattern. Those differences in pigmentation, for the most part, are to be expected, since the types were collected in a silty habitat in contrast with the very clear water of the Mountain Fork. In silty water melanophores often become so small that they are easily overlooked.

I wish to express my thanks to Dr. Carl L. Hubbs for checking my identification of this specimen, and to Bryan P. Glass and Joshua Harmon for their field assistance.—GEORGE A. MOORE, *Department of Zoology, Oklahoma Agricultural and Mechanical College, Stillwater, Oklahoma.*

[1] Contribution No. 138, Oklahoma Agricultural and Mechanical College.

Herpetological Notes

PSEUDOTRITON RUBER IN CENTRAL NEW YORK STATE.—The red salamander, ***Pseudotriton ruber ruber*** (Latrielle), has been known from New York state only in the eastern and southwestern portions, which are separated by a gap of more than 200 miles. On July 26, 1942, the junior author discovered this species 8 miles north of Elmira, Chemung County, New York, very near the middle of this gap in the known distribution. The nearest authentic New York records are more than 100 miles west and east; the nearest Pennsylvania record is from near Williamsport, about 65 miles south.

Efforts have been made subsequently to determine the extent of the distribution of this salamander in this part of the state and in areas separating this station from the rest of the known range. These studies have revealed ***Pseudotriton*** only at the original station and its immediate vicinity which comprises the remnants of a tamarack bog in and about which are a number of springs and seepages. Here we have found specimens in eight places, usually a spring or seepage area near the edge of the bog. Each place was separated from the next nearest by at least several hundred feet in which no specimens could be found and in which the habitat was apparently unsuitable. These eight "substations" were scattered over an area a mile long and one-third as wide. Larvae were found at only three places, and in fact it is very possible that there may be only two or three permanent substations in the area. At only two of the places were more than two individuals of the species found. During many trips a total of 80 transformed and 76 larval individuals have been observed, mostly at the two locations mentioned.

Through observations on the presence of ***Pseudotriton*** in the various parts of its environment, and analysis of a number of habitats where at first we expected, but failed to find the species established, it appears possible to make certain generalizations on the normal habitat in this part of its range. The presence of ***Pseudotriton*** in numbers is apparently correlated here with the presence of (1) a spring with a constant flow of very cold water, (2) many square yards of soft muck adjacent to the spring or to the first few yards of its outlet, (3) many pieces of debris such as stones, sticks, and logs lying on the surface of this muck, (4) densely growing aquatic plants such as water cress or ***Chara*** in the cold water, and (5) stones of various sizes in the spring itself. It may or may not be significant that all three of the springs near which larvae were found appear to issue from the ground by a horizontal flow, whereas other springs in the area issuing by a vertical flow did not reveal ***Pseudotriton*** in their vicinity. Theoretical advantages of a horizontal underground flow for breeding and wintering in this cold climate can be imagined.

From April to October most adults were found beneath stones, sticks, and logs 2 to 30 feet from the water's edge, in a position obviously attained by a burrow through the muck; a very few were under objects in shallow spring water. Rarely were individuals observed more than 100 feet from the source of a spring even when other habitat factors seemed to remain the same (except perhaps water temperature).

Investigation of the Elmira-Horseheads-Big Flats valleys south and west of the *Pseudotriton* station reveals many constantly flowing cold springs whose outlets have muck borders and a dense growth of water cress and which, before the advent of the white man, may have had also the remaining requirements for ***Pseudotriton***. However, all of these habitats have been altered at least somewhat either by pollution, dredging and draining, removal of ground surface debris, or changes of the structural character of the springs to fit them for use as a water supply for man or his livestock. ***Pseudotriton***, with its highly specialized requirements, probably cannot survive these changes.

Pseudotriton from Chemung County, New York, appears to be indistinguishable from *Pseudotriton ruber ruber* elsewhere in its range.

Twenty-three adults collected October 13, 1946, when placed in formalin disgorged the following: 10 earthworms, 2 puparia of species of Diptera, 1 cricket (***Gryllus***), 1 sow bug (*Oniscus*), 1 larva of water scavenger beetle (***Hydrophilus***).—HAROLD H. AXTELL and RACHEL C. AXTELL, ***Buffalo Museum of Science, Buffalo, New York.***

CLASPING IN THE SALAMANDERS *ANEIDES* AND *DESMOGNATHUS*.—Bishop (1943 Handbook of Salamanders) states that nothing is known of the mating habits of the green salamander, *Aneides aeneus* (Cope), or the pygmy salamander, *Desmognathus wrighti* King. On the night of June 13, 1941, I. B. Boggs, W. A. Lunk, Gene Frum, and I were collecting salamanders on sandstone cliffs near Summersville, Nicholas County, West Virginia. Green salamanders in good numbers were climbing on the faces of the cliffs. At a point about 2 miles east of Summersville, we found a clasping pair and we had it under observation between midnight and one o'clock. The animals were in the position normal for plethodont salamanders. There was a constant movement on the part of both individuals, with body undulations and shifting of mouthholds. We saw no spermatophores deposited or picked up. A light rain was falling, and the cliff face was very wet. The clasping pair was completely exposed, about 8 feet above the ground.

On May 23, 1945, accompanied by Arthur Stupka, Park Naturalist, I climbed Mt. Kephart, along the Appalachian Trail east of Newfound Gap in the Great Smoky Mountains National Park, Tennessee-North Carolina. At an elevation of approximately 6,100 feet, I turned over a small log of yellow birch, (*Betula lutea*), under which was a clasping pair of pygmy salamanders. Unfortunately, this pair was disturbed, and broke their clasp. The time was about 10.30 A.M., and the day warm and sunny. There had been light showers the previous evening, and the ground and under-surface of the birch log were quite damp.

I have found pygmy salamanders quite frequently under yellow birch logs and bark. I do not know of any other Appalachian salamander that chooses logs of this species for diurnal hiding places.—MAURICE BROOKS, *West Virginia University, Morgantown, West Virginia.*

THE SPADE-FOOT TOAD, *SCAPHIOPUS H. HOLBROOKII*, BREEDING IN SOUTHERN OHIO.—On June 1 and 2, 1946, a total of 3.71 inches of rainfall was recorded at the U. S. Weather Station at Chesapeake, Lawrence County, Ohio. On the evening of June 2 a breeding chorus of spadefoots was located 1.7 miles east of Coalgrove, about 150 yards south of U. S. Route 52. The breeding area was a pasture situated on an old terrace about 20 feet above the present Ohio River flood plain. At least 25 male *Scaphiopus* called from a large temporary pool that covered about one-third of a 4 acre field. Clasping pairs and eggs were collected. The spot was visited again on June 8 and large numbers of tadpoles were observed in the small pool that remained. Some of these tadpoles were taken to the Stone Laboratory, Put-in-Bay, Ohio, where they were reared through transformation by feeding them an algal growth, rich in animal life, that was scraped from the dock piling below water level.

During the morning of June 8, 1947, 2.58 inches of rain fell over the same general area as above. That evening breeding choruses were found along the Ohio River at the following localities: two at the eastern edge of South Point, a large chorus on the South Point chemical grounds, one at the western edge of South Point, one 2 miles west of South Point, one at the eastern edge of Ironton, one at the western edge of Ironton and one 5 miles west of Ironton. There was scarcely a spot between South Point and Ironton where one was out of range of their calls. One male was heard calling the same evening near Burlington, 4 miles east of South Point, by Milton Trautman. Other frog voices heard the same evening over the same general area were *Hyla c. crucifer, Hyla v. versicolor, Bufo woodhousii fowleri* and *Pseudacris brachyphona*. At the station on the western edge of Ironton the first three of these species were calling from the same pools with *Scaphiopus*. At other localities ecological segregation was more pronounced.

The breeding areas comprised large temporary pools that were located in gardens, plowed fields, vacant lots and trash dumps. Although roadside ditches were filled with water no spadefoots utilized this habitat. By June 9 most of the pools examined had shrunk to a fraction of their former size, leaving large numbers of eggs stranded on the ground.

Scaphiopus h. holbrookii was first recorded from Ohio by Gier (1945, COPEIA: 50) on the basis of one specimen from Athens. It is evident from the present records that the spadefoot is abundant and widespread along the Ohio River in Lawrence County.—N. BAYARD GREEN, *Dept. of Zoology, Marshall College, Huntington 1, West Virginia.*

RECORD *NECTURUS* FROM WISCONSIN WATERS.—Among the specimens of *Necturus maculosus stictus* Bishop, received at Wards Natural Science Establishment at Rochester, New York, in June, 1947, from Lake Winnebago, Wisconsin, a single female specimen was considerably larger than the average for this subspecies. After about three months in preservatives the measurements are as follows: total length 19⅛ in.; tail, 6¼ in.; head length, measured at the level of the mouth to the lateral extension of the gular fold, 2½ in.; head width, 2⅝ in. The largest specimen of the typical subspecies (*N.m. maculosus*) of which I have record was 17 inches in total length.—SHERMAN C. BISHOP, *Department of Zoology, University of Rochester, Rochester, New York.*

RETENTION OF EGGS BY THE TURTLE *DEIROCHELYS RETICULARIA*.—The tendency of turtles to retain eggs when conditions are not suitable for proper deposition has been reported by Risley (Mich. Acad. Sci., Arts and Letters, 17, 1933: 694) from observations on a musk turtle, *Sternotherus odoratus* (Latreille), that was held captive during the laying season and released in the fall. The same individual collected the following spring had 3 newly formed eggs in the oviducts and 3 with intact shells in the abdominal cavity. Females of the genera *Chrysemys, Pseudemys,* and *Chelydra* retained in captivity in the Tulane Zoology Laboratory did not deposit their eggs. It is routinely necessary to dissect such individuals to procure eggs if a suitable area of soil is not made available for nest construction (Cagle, COPEIA, 1944: 60).

A female chicken turtle, *Deirochelys reticularia* (Latreille), collected in March, 1946, was kept in an aquarium until January 30, 1947. Palpation indicated that eggs with the shell completely developed were present in the oviducts June 10. When the turtle was opened January 30, 1947, 3 eggs with intact shells were free in the abdominal cavity and 4 eggs remained within the oviducts, 3 in the left and 1 in the right.

The method of entry of the eggs into the abdominal cavity was apparent. The upper portion of the left oviduct had two holes present at intervals approximating the distance between eggs when present in the oviduct. A similar opening was present in the upper part of the right oviduct. The upper end of each egg remaining within the oviducts projected from an opening eroded by the movement of the end of the egg against the oviducal wall. The opening above the lower egg in the left oviduct was so large that a slight pressure beneath the egg caused it to move from the oviduct into the abdominal cavity. The openings above the others were too small to permit their escape.

Sections of the oviduct cut through the eroded areas indicate no strong histological differentiation of the oviducal walls. The general appearance is that of an oviduct that was simply "worn out." The submucosal connective tissue is much more dense in the region of the erosion and numerous red-staining granules of unidentified origin can be seen. The relative thickness of the various layers does not appear to be modified.

Risley (*ibid.*: 644) supposes that the presence of eggs in the abdominal cavity implies a reversal of the normal direction of passage of eggs through the oviducts. Apparently such reversal does not occur in *Deirochelys.*

The question immediately arises as to the possible effect of this injury to the oviduct and as to the method of elimination of eggs free in the abdominal cavity. If such damage and retention of eggs were fatal, zoos would have frequent losses of female turtles, as suitable areas are rarely provided for nest construction. Such mortality does not occur. Thus the oviducal damage and free eggs in the abdominal cavity appear to have no serious effect on the turtle.

The retention of eggs may explain reports of unseasonal presence of eggs and irregular deposition. Miller (1932, Trans. San Diego Society of Natural History, 18: 190) reported a gopher turtle that deposited 1 egg on October 4, another on the 7th, 2 on the 8th, and a 5th on the 30th of October. The turtle was kept on a balcony and probably did not have satisfactory conditions available for deposition of eggs. Netting (COPEIA, 1929: 24-25) received 3 turtles from Hillsboro County, Florida, that were collected January 4. 1927. The largest of these deposited eggs on January 6 and January 14. Perhaps these were collected from an area in which proper nesting conditions were not available.—FRED R. CAGLE and JOSEPH TIHEN, *Department of Zoology, Tulane University, New Orleans, Louisiana.*

AN ENEMY OF THE HORNED LIZARD.—Nature has done much for the horned lizards (*Phrynosoma*) by way of protection from predatory enemies. Their color pattern renders them inconspicuous against their habitual background. The flattened body form conceals most of its own shadow by closely hugging the ground. The marginal scales tend to obliterate the outline of the body, especially since a slight wriggling motion on coming to rest will bring loose particles of the substrate up over the edges of body and tail to further the concealing effect. The powerful spines bordering the head in many species would presumabily have a deterrent effect on some types of predator, although I have never seen an actual case in which, as has been popularly reported, these 'horns" have pierced the body wall of a snake that had swallowed a "horned toad."

The efficacy of these protective measures is possibly to be correlated with certain other characters of *Phrynosoma*. The various species frequent open country very largely. They are slow moving and have little active defense. When captured they commonly remain passive. The celebrated "blood-spitting" is harmless, though repellant to a degree, and is but rarely observed. The low birth rate would certainly suggest a low mortality rate.

During a lifetime acquaintance with the horned lizards in California, I have never until the past year observed a case of one having fallen victim to a predator. On May 8, 1946, I prepared a freshly taken specimen of the prairie falcon (*Falco mexicanus*) from the desert 30 miles east of Indio, California. In its stomach were the hind feet and the terminal half of the tail of a horned lizard neatly snipped off. In addition there were small fragments of reptile bone that I could not identify with certainty, but have no reason to doubt belonged to the same individual. Mr. Gerhard Bakker, of Los Angeles City College, determined the species as *Phrynosoma platyrhinos*, which is the form one would expect from that area.

The prairie falcon is a hunter who plucks his game, if it be a bird. Presumably this one had pretty thoroughly skinned the lizard and had picked the meat from most of the carcass, bolting only the tail and the feet. The latter had been snipped off about midway of the tibiae. The coarser scales and the cephalic horns (not at the maximum in this species) had thus been avoided.—LOYE MILLER, *University of California, Los Angeles, California.*

DISTRIBUTIONAL RECORDS OF AMPHIBIANS IN EAST TEXAS.—The distribution of several amphibians is as yet poorly known in the state of Texas. During the past months a few facts concerning some of these forms have been gathered in the field or brought to my attention by others. These data are as follows:

Manculus quadridigitatus (Holbrook).—Dr. S. C. Bishop (1943, *Handbook of Salamanders*: 446) gives the Trinity River as the western limit of the range of the dwarf four-toed salamander. Two specimens of this species, a male and a female, were taken on December 26, 1946, in Sam Houston Home Grounds, Huntsville, Walker County, Texas. These were found in the shade of a stone wall, underneath decaying leaves on moist, sandy soil.

Measurements are as follows: male; snout to vent, 28.5 mm.; tail, 42.0 mm.; head length, 7.0 mm.; head width, 4.5 mm. Female: snout to vent, 28.0 mm.; tail, 32.0 mm.; head length, 6.0 mm.; head width, 4.0 mm. Coloration typical. Several eggs were visible through the body wall of the female.

Another male was taken from a small rotting stump, in a creek bed, 4 miles northeast of Huntsville on March 8, 1947. This specimen was slightly smaller than either of the above.

Mr. Bryce C. Brown of the Agricultural and Mechanical College of Texas informs me that this species is not uncommon still farther west. He has taken specimens from near Hanover, Milam County, and from 6 miles east of Kenney, Austin County.

The distribution of *M. quadridigitatus* in Texas includes the eastern portion of the state, to a few miles west of the Brazos River.

Hyla crucifer Wied.—The wide ranging spring peeper has not, until recently, been recorded from the state of Texas. Bryan P. Glass (1946: 103) records it from Normangee Lake, Leon County.

A gravid female of this species was obtained 2 miles east of Livingston, Polk County, Texas, on December 22, 1946. This specimen was found 50 yards north of Highway 190, next to a rotting sweet gum log, 25 yards south of a clear, sandy bottomed creek, in a

pine-beech-white oak-magnolia association. Other noticeable trees in the vicinity of the creek were willow oak, holly, linden, and sugar maple. Sandy top soil is characteristic of this region.

Measurements of this specimen are as follows: snout to vent, 34.0 mm.; head length, 10.0 mm.; head width, 10.0 mm.; femur, 14.0 mm.; tibia, 16.0 mm.; foot, 22.0 mm.; longest toe, 8.0 mm. Coloration typical. Eggs were visible through the distended body wall. By actual count the vitelli in the left ovary numbered 596, or about 1,192 for the entire complement.

On the evening of January 26, 1947, a number of *H. crucifer* were heard calling from a marshy area 1 mile south of Phelps, Walker County. None of these were collected. A few were heard calling at the south edge of Huntsville, Walker County, during the evening of February 13, 1947. This area was visited during the evening of February 16, and in a shallow, grass grown, brushy, stagnant creek in a small pine woods, a few yards west of Highway 75, dozens of *H. crucifer* and *Pseudacris nigrita triseriata* were calling. One *Rana clamitans* was also heard. Three specimens of *H. crucifer* were collected, all males; no females were observed. These three typically colored males had the following measurements: snout to vent, 32.0 mm., 28.0 mm., and 30.0 mm.; head length, 9.0 mm., 8.0 mm., and 8.0 mm.; head width, 9.0 mm., 8.5 m., and 9.0 mm.; femur, 11.0 mm., 10.0 mm., and 11.0 mm.; tibia, 16.0 m., 14.0 mm., and 15.0 mm.; foot, 22.5 mm., 19.0 mm., and 20.5 mm. These measurements, and those of the female, are slightly greater than those given by Wright and Wright in their *Handbook of Frogs and Toads* (1942).

During the evening of March 22, 1947, a large chorus of this species was heard 1 mile south of Conroe, Montgomery County. Several other choruses were heard between this locality and Huntsville, Walker County, along Highway 75.

Mr. Brown tells me that he has taken *H. crucifer* at two other localities in east Texas. His specimens are from near Hanover, Milam County, and from Houston, Harris County.

These records indicate that the range of *Hyla crucifer* in Texas includes all of the eastern mesophytic forests and extends westward, in suitable localities, into the adjoining post oak and prairie regions.

Rana palustris (Le Conte).—This form has been taken in Texas 4 miles east-north-east of Huntsville, Walker County. The specimen, a male, was flushed from a pipe into a concrete drainage ditch of the State Fish Hatchery, on March 14, 1947. Measurements were: snout to vent, 51.0 mm.; head length, 17.5 mm.; head width, 18.0 mm.; femur, 21.0 mm.; tibia, 22.0 mm.; foot, 37.0 mm. The rectangular dorsal markings and orange under parts of femur and posterior portion of the abdomen were typical. The species has been recorded from the state previously only by Smith and Brown (1946: 73).

Rana sphenocephala (Cope).—The distribution of this form is not well defined in Texas. Stejneger and Barbour's last *Check List* (1943: 58) gives its range as extending westward in the coastal plain to northeast Texas. On March 14, 1947, a gravid female was collected at the edge of a concrete drainage ditch at the State Fish Hatchery, 4 miles east-north-east of Huntsville, Walker County. Measurements were: snout to vent, 65.0 mm.; head length, 23.0 mm.; head width, 20.0 mm.; femur, 28.0 mm.; tibia, 39.0 mm.; foot 50.0 mm. Head in length, 2.82; snout in length, 6.50; tibia in length, 1.66.

During the evening of May 19, 1947, three males were heard calling from a small (5½ feet x 8 feet x 1½ feet deep) permanent pool in the Sam Houston Home Grounds, Huntsville, Walker County. Two of these were collected. They were sitting back about 1½ to 2 feet from the edge of the pool, under vegetation. Measurements of the larger specimen were as follows: snout to vent, 69.0 mm.; head length, 23.0 mm.; head width, 21.0 mm.; femur, 32.0 mm.; tibia, 41.0 mm.; foot, 53.0 mm. Head in length, 3.00; snout in length, 6.57; tibia in length, 1.68.

All of the above specimens had the typical white spot in the center of the tympanum, head long and snout pointed, heavily spotted lower lip, vermiculate lower portion of the sides, and narrow bars on the femur and tibia.

These records show that the species occurs in both the inner coastal plain of very deep sands and short leafed pine, and in the outer coastal plain of shallow sands underlain by a "hard pan" type of sub-soil and characterized by long leafed pine. The general similarity of both of these regions, however, indicates that *R. sphenocephala* occurs, as do other eastern forms, throughout the eastern mesophytic forests of east Texas.—Robert L. Livezey, *Sam Houston State Teachers College, Huntsville, Texas.*

LOCALITY RECORDS OF PACIFIC ISLAND REPTILES AND AMPHIBIANS.—In connection with ornithological work in the north central Pacific Ocean a number of specimens of reptiles and a few amphibians have been taken in the last three years. Dates and locality records may be especially significant in tracing the spread of such introduced forms as the marine toad (*Bufo marinus*) and the Japanese frog (*Rana rugosa*). The several hundred specimens in this collection are now at the University of Hawaii. I wish to express my appreciation to Dr. James A. Oliver, of the American Museum of Natural History, who has examined typical specimens and has verified all identifications.

Bufo marinus.—Abundant on Ponape and on all the larger islands of the Hawaiian Group. Although present on all islands at Yap, it was most abundant near Yaptown, Yap Island, where apparently it was first liberated.

Rana rugosa.—Specimens from Oahu, Territory of Hawaii, are not typical of the species as known in Japan. The only records of occurrence in the Hawaiian Islands are from Maui and Oahu. The author has found them only in the Manoa and Makiki streams on Oahu at elevations from 400 to 1000 feet.

Gehyra mutilata.—In the Hawaiian Islands specimens have been taken near sea level at Halape, Hawaii, at Mapulehu, Molokai and at Waikiki Beach, Oahu. Two specimens were collected at sea level at Yaptown, Yap Island.

Gehyra oceanica.—A single specimen from Rita Island at the east end of Majuro Atoll in the Marshall Islands is my only record.

Hemidactylus garnotii.—Three specimens from the Territory of Hawaii are at hand, one from Kalama Beach, Oahu, and two from 4000 feet in Hawaii National Park, Hawaii.

Hemiphyllodactylus typus typus.—Kalama Beach, Oahu, T.H., is the only locality.

Lepidodactylus lugubris.—This species is common at the following places: Rita Island, at Majuro Atoll, Marshall Islands; Mapulehu, Molokai, T.H.; at elevations up to 400 feet on Oahu, T.H.; and at Yaptown, Yap Island. A single specimen was obtained on Keaoi Islet, off the southeast coast of Hawaii, T.H.

Ablepharus boutonii poecilopleurus.—My only records are from Keaoi Islet, off the southeast coast of the island of Hawaii, and from 3200 feet in the Kau Desert, Hawaii, T.H.

Dasia smaragdina viridipunctum.—Specimens of this lizard were collected in the following localities: Lele Island, Kusaie Group; Majuro Island, Majuro Atoll, Marshall Islands; Tabal Island, Aur Atoll, Marshall Islands; and on Yap and Rumung Islands of the Yap Group.

Emoia cyanura.—In the Yap Group of islands specimens were taken on Yap, Tomil and Rumung Islands. This lizard was also found at Tabal Island, Aur Atoll, and on Rita and Majuro Islands of the Majuro Atoll, Marshall Islands, as well as on Lele Island of the Kusaie Group.

Emoia nigra.—Localities for this species are: Lele Island, Kusaie; and Yap, Tomil and Rumung Islands of the Yap Group.

Lygosoma (Leiolopisma) hawaiiensis.—This skink is common at elevations from sea level to 1500 feet on the island of Oahu, T.H.

Varanus indicus indicus.—The monitor was found on all islands of the Yap Group, from the highest (550 feet) forests to the mangrove swamps at sea level. Water monitors probably belonging to this species were seen, but not collected, on Ponape and Kusaie of the eastern Caroline Islands, on Angaur of the Palau Group, and on Aur Atoll in the Marshall Islands. Natives in the Marshall Islands reported that the Japanese transplanted these large lizards to one or two islands of each of several atolls and that they were used as food by the Japanese. At Ponape it was stated that the monitors were brought in to aid in controlling rats, although some monitors may have been there before.

Typhlops braminus.—This small, burrowing snake is rapidly increasing its range on the island of Oahu, T.H. Before 1930 only a few specimens had been found, and these were localized around the Kamehameha Boys' School in Honolulu. Apparently it was first introduced to the territory in the soil about the roots of exotic plants used in landscaping the grounds around the school. Within the last year specimens have been obtained from St. Louis Heights, Wilhelmina Rise and lower Manoa Valley in Honolulu, which localities are several miles from the site of the original specimens. The commercial hauling of top soil and the constant movement of large, potted shrubs from place to place are probably the major factors in establishing it in new localities.—HARVEY I. FISHER, *Department of Zoology and Entomology, University of Hawaii, Honolulu, T.H.*

Reviews and Comments

TOMORROW'S A HOLIDAY. By Arthur Loveridge. Harper and Brothers, New York: VII + 278. $3.00.—With the advance of civilization, and, during recent decades, with the advance of aerial mapping, the geographic exploration of the world has reached so high a level that unknown lakes or unnamed mountains no longer offer goals to explorers. Fortunately for our generation there remains the next line of attack in scientific exploration—the study of the distribution of plants and animals, and, in remote regions, of native human tribes; even in civilized communities much of this kind of exploration remains. How interesting and exciting the collecting of animals may be in Africa to this day is well set forth in the two popular books by Arthur Loveridge that now supplement his long series of technical reports on African reptiles and amphibians. The second of these books forms a natural successor to *Many Happy Days I've Squandered.*

Tomorrow's a Holiday is dedicated to Salimu *bin* Asmani, the East African collector who has been Loveridge's faithful and efficient assistant on expedition after expedition, and thus does justice to a friendship that has bridged decades of years, wide oceans, and the gulf between the white and colored races of mankind. Mr. Loveridge's continued relations with Salimu form a counterpart to the late Harry Raven's life-long correspondence with his Malay hunter on North Celebes.

Tomorrow's a Holiday takes up the account of successive collecting expeditions to East Africa for the Museum of Comparative Zoology at Harvard, in which the main emphasis was on the search for new and little-known caecilians, frogs and toads, lizards, snakes, and turtles, though birds and mammals and certain insects and invertebrates were also actively collected. It is pleasant to meet "Memsah'b Mary" and "Bwana Briani" in these pages. The running account of the intimate day to day contact with African animals discloses something of the great fascination of the game of collecting (beside which big game hunting seems peurile), and affords an extensive introduction to the natural history of Africa. Much of the merit and usefulness of the book lies in the fact that its information is so entirely trustworthy, and is set forth without exaggeration of any kind. This may result, for readers' without some background of interest in natural history, in a kind of monotony, in which the transition from bird to lizard adventure is too often at the same level. For naturalists of any kind, and above all for those who have any other introduction to Africa, the book is essential.

The wealth of African life and its extraordinary nature has been known to a degree from the time of the discovery of gorillas by the Carthaginians and of the Roman circuses, whence came the aphorism "Ex Africa semper aliquid novae." A great series of creatures new to science, and sometimes startlingly novel, has only during the present century become known, and Arthur Loveridge has made notable contributions to this knowledge. His book should surely be included in the head-borne (perhaps now more probably jeep-borne) library of anyone on safari in the Dark Continent, for which the best illuminants are the accounts of the naturalist travellers, from Livingstone to Loveridge.—Karl P. Schmidt, *Chicago Natural History Museum, Chicago, Illinois.*

LA VIE DES REQUINS. By P. Budker. Nr. 7 of the Collection Histoires Naturelles, Librairie Gallimard, Paris, 1947: 279 pp., 40 figs., 22 pls. 325 francs.—In nine chapters, the author, who is Sub-Director of the Laboratory of Colonial Fisheries, of the Museum of Natural History in Paris, gives a semi-popular account of the life of the sharks, covering classification, morphology, gross anatomy, feeding habits, man-eaters, fresh-water sharks, remoras, legends and fisheries of the sharks, with special consideration to the divers subproducts. Though the book was written for the interested layman, it brings together many data of interest not readily found elsewhere in the scattered literature on the subject. The non-specialist will find useful information on several anatomical details, and the chapter on feeding habits gives a general account of what is known. The book is well illustrated, though the reproduction of the photographs is sometimes poor.—Herman Kleerekoper, *University Museums Annex, Ann Arbor, Michigan.*

CREATURES OF MYSTERY. By Gray Meek. Macon, Georgia, J. W. Burke Company, 1946: xii + 274 pp., illus. $4.00.—When I was very young in the serious study of herpetology I had two vivid encounters with the living mythology of the serpent in the United States—with the blow-snake story in Wisconsin and with the even more dreaded hoop snake of the South. After hearing the stories of the venomous breath and venomous tail sting (respectively), of both of these snakes, and after obtaining a minute and unmistakable description of the snakes in question, I had the good fortune to capture living specimens and could confront my informants with the direct demonstration that their firmly believed and much eye-witnessed stories were not true. In Wisconsin, some of my neighbors preferered to retain their beliefs by means of the hypothesis that I had occult power over my snake subjects, acquired from the devil. In Louisiana, my best story-teller attempted to deny that the mud snake wrapped around my wrist was the species with a poisonous sting in its tail; but he had described its gray back and shiny scales and brilliantly red belly so well that our gang of oil-men forced him to admit that I had indeed captured the stingin' snake and that it visibly had no sting.

The subject of *Creatures of Mystery* is the Florida diamond-back rattler, and the hero of the book is an experienced snake catcher, David Nettles. The author (and "Uncle Dave") are certain that the "experts," the more literate writers of books about snakes, are in error in many matters about snakes in general and about diamond-back rattlesnakes in particular. Mr. Meek asserts, for example, and offers Uncle Dave's lifelong observation as support, that the rattlesnakes fascinate their prey; that rattlesnakes have an audible mating call, given at dawn and dusk; that they lay eggs; and that the young are taken into the mother's mouth in time of danger. An extraordinary feature of the book, which is an unduly expanded and verbose series of stories about encounters with the diamond-back rattlesnake, lies in its repeated examples of logical deduction from false premises. The reasons alleged for a belief in a "mating call" of rattlesnakes afford a sample. The fact is that whether in civilized or in quite uncivilized countries the native lore of natural history is a mixture of acute observation of fact and an elaborate structure of misinterpretation and myth, and in every case requires shifting and criticism by the scientific method, which requires no college education for its application.

An error more grievious than is involved in any of the snake stories in *Creatures of Mystery* lies in the tacit assumption that the "professors," the "herpetologists," depend entirely upon books for their knowledge of snakes, and that their reports are thus at a disadvantage when compared with the eye-witness evidence of an Uncle Dave Nettles. It is to be regretted that Uncle Dave and Mr. Meek could not extend their acquaintance to the western diamond-back and to my favorite snake catcher, J. E. Johnson, Jr., of Waco, from whom this herpetologist has learned much more than has Mr. Meek from Mr. Nettles.—Karl P. Schmidt, *Chicago Natural History Museum, Chicago, Illinois.*

Editorial Notes and News

Gray Whale Study An expedition from the Scripps Institution of Oceanography spent about two weeks in February in Baja California. The prime purpose of the trip was the photography and observation of the gray whales in the lagoons where they breed. This species has undergone a tremendous increase in population recently. In connection with the whale observations, fish collections were made by Clark and Earl Hubbs at Turtle Bay and by Carl and Laura Hubbs and party at Abreojos. The party was transported between those points by the "E. W. Scripps," which was conducting offshore work, including a first study of the spawning of the California sardine far off the shore of Lower California.

Western Division

THE WESTERN DIVISION of the AMERICAN SOCIETY OF ICHTHYOLOGISTS AND HERPETOLOGISTS will hold its 1948 meeting in conjunction with the PACIFIC DIVISION of the AAAS at Berkeley, during the week of June 21–25. Meetings will be held as follows:

Tuesday, June 22
9:00 A.M. and 2:00 P.M.—Presentation of papers.
Wednesday, June 23
9:00 A.M.—Symposium in Herpetology (joint meeting with WESTERN SOCIETY OF NATURALISTS);
11:30 A.M.—Business Meeting;
2:00 P.M.—Symposium: Racial Studies in Fishes (joint meeting with WESTERN SOCIETY OF NATURALISTS).

Dr. J. L. Kask and the FAO

THE FOOD AND AGRICULTURE ORGANIZATION of the United Nations announced recently (January 15, 1948) that DR. JOHN L. KASK, of the United States of America, has been appointed to head the Biological Branch of the FAO Fisheries Division. Dr. Kask, Curator of Aquatic Biology at the California Academy of Sciences, was expected to take up his new duties with FAO last January 16. Dr. Kask already has considerable experience of the international aspects of fisheries problems. From 1928-38 he was Associate Scientist of the International Fisheries Commission (USA and Canada). For the next six years Dr. Kask served as Assistant Director of the International Pacific Salmon Fisheries Commission. He also spent two years in Japan as Assistant Chief of the Fisheries Division on the staff of the Supreme Commander for Allied Powers.

Dr. Kask's immediate work at FAO will be to organize Regional Fisheries Councils. Fishery conservation and management problems on the high seas are international in character, but because these problems differ widely in the many areas involved, Fisheries Councils are being established by FAO on a regional basis to assist governments to develop fully their natural fisheries resources. Specific problems to be studied include distribution of species, seasonal variations in abundance, the effect of fishing operations on numbers, and effective methods of propagation, stocking and control of disease and pollution.

The FAO Geneva Conference last summer recommended the setting up of these Regional Councils for the Northwest Atlantic, Southwest Pacific and Indian Ocean, Mediterranean Sea and contiguous waters, Northeast Pacific, Southeast Pacific, Western South Atlantic, Eastern South Atlantic, and Indian Ocean (African area). Thirteen countries bordering on European waters, comprising the Northeastern Atlantic, North Sea and the Baltic Sea, fall within the scope of the Permanent International Council for the Exploration of the Sea, established in 1899 with headquarters at Copenhagen, Denmark.

FAO will concentrate on establishing Councils in regions where no such service is already in existence. Preliminary work on the establishment of Regional Councils in the Indo-Pacific area was scheduled for the FAO Fisheries Conference held in the Philippine Islands late in February, 1948.

Saving the Redwoods

THE NATIONAL TRIBUTE GROVE.—To complete the program for the National Tribute Grove and its wilderness setting, funds must be raised to acquire primeval redwood forest lands along the Smith River and Mill Creek, in Del Norte County, California. This great grove is being established and preserved in honor of all who served in the armed forces of the United States in World War II, those who live as well as those who gave their lives. It symbolizes our people's eternal gratitude—eternally expressed. Many of the giant redwoods are 2,000 years old, and are more than 350 feet in height. They are the tallest of all trees. The State of California will give one-half the amount needed to preserve them. The SAVE-THE-REDWOODS LEAGUE hopes to raise the other half—the "matching funds" required—and will appreciate your participation in its program, never more timely than now. You can aid by membership or by donation. An annual membership is $2.00; Contributing, $10.00; Sustaining, $50.00; Life membership, $100.00. Donation, amount optional. Whichever you choose, your contribution will accomplish much. SAVE-THE-REDWOODS LEAGUE, 250 ADMINISTRATION BUILDING, UNIVERSITY OF CALIFORNIA, BERKELEY 4, CALIFORNIA.

U. Miami Marine Laboratory

CONCERNING the MARINE LABORATORY OF THE UNIVERSITY OF MIAMI, at Coral Gables, Florida, PROFESSOR H. G. WALTON SMITH, director of the laboratory, sends the following report.

"The Marine Laboratory is primarily a research institution but the scientific staff co-operate with the teaching departments of the University by giving both under-graduate and graduate courses in the fields of oceanography, marine biology, and fisheries biology. Graduate students may be given the opportunity of taking part in various research projects as part of their training.

"An important part of our activities is concerned with the development and management of fisheries in Florida and the West Indies. We are under contract for work of this nature with the State of Florida and with several of the West Indian governments. In addition to this the Laboratory carries out work for industrial organizations in the development of marine products and in investigating such problems as the affect of industrial pollution upon fish, oysters, and other marine life. We are also under contract to the United States Navy in the study of tropical deterioration and have carried out a number of investigations upon submarine corrosion and ship bottom fouling.

"Along with applied science we endeavor to maintain a program of fundamental investigation into the ecological conditions and the biological and oceanographical problems of the tropical seas. We have recently completed an investigation of the "red tide" phenomena of an enormous plankton bloom in the Gulf of Mexico. We are also studying the inter-relation of chemical, physical, and biological conditions of the water adjacent to Miami. As a necessary adjunct to the various phases of our work we maintain a museum of Florida and West Indian marine plants and animals for the purpose of research and reference. This is being continually enlarged and we hope will eventually become an important regional center for the West Indies and Caribbean region.

"Our staff consists of DR. ROBERT H. WILLIAMS, Assistant Director, who is a marine botanist, DR. CHARLES C. DAVIS, a specialist in plankton, MR. CRAIG A. GATHMAN, Fisheries Biologist, DR. ERNEST S. REYNOLDS, Microbiologist, and DR. LUIS R. RIVAS, Ichthyologist. In addition we have graduate assistants working in the various specialized fields.

"The Laboratory was first organized by myself in December of 1942 and since then a considerable part of our work has been in the field covering investigations in different parts of the Caribbean, the Bahamas, the Gulf of Mexico, and the Florida Keys. Partly because of this I must confess that our physical plant is inadequate. We are hoping, however, to build a permanent building at the cost of $150,000 sometime during the present year. A suitable site has already been secured and part of the funds are already available."

Arnhem Land Survey

A SURVEY of the natural resources of Arnhem Land in northern Australia is being undertaken jointly by the AUSTRALIAN GOVERNMENT, the SMITHSONIAN INSTITUTION, and the NATIONAL GEOGRAPHIC SOCIETY. Field work in this little explored aboriginal reserve is expected to last from the close of the rainy season in early March until sometime in October. DR. ROBERT R. MILLER will study the fish life and will also make collections of reptiles and amphibians, and other animal groups as opportunities arise. The relatively unknown freshwater fish fauna will be emphasized, but ample time for exploring the coral reefs, tide pools, open beaches, and the surf will assure a large collection of marine fishes. The expedition will work from three land and two island bases and will move from base to base by boat.

News Notes

THE three agencies of the U. S. DEPARTMENT OF THE INTERIOR which were transferred to Chicago in 1942 have completed the transfer back to Washington. These are the Park Service, the Indian Service, and the Fish and Wildlife Service. Liaison offices of all three agencies were maintained during the war in Washington, and the Division of Commercial Fisheries was never transferred to Chicago. Prior to October, 1947, the Divisions of Fishery Biology and Alaska FIsheries moved back, and during October the Division of Game, Fish and Hatcheries and the divisions concerned with birds and mammals were returned to the Capitol.

Mr. E. M. Buchanan, Life Member of the Society whom many members will recall having met at the Pittsburgh meeting in 1946, has now returned to China after a 117-day trip from London to Tsingtao. Mr. Buchanan, who may be addressed % Yee Tsoong Tobacco Co., Ltd., Tsingtao, Shantung, China, would be glad to receive herpetological literature from other members of the Society. In a letter to the Secretary he has the following to say about museums in southeastern Asia. The Secretary has transmitted his request for aid for these museums to the Museums Section of UNESCO, but will be happy to receive suggestions from members who have any other ideas about obtaining the needed support for these institutions.

"At Singapore I spent most of the time at the Raffles Museum studying the reptiles and amphibians stored there, by kind permission of the Director, Mr. M. W. F. Tweedie, who was very generous in giving me the benefit of his extensive knowledge of the Malayan Fauna. In Hongkong I had the pleasure of meeting Dr. G. A. C. Herklots, who kindly allowed me to dig for some specimens of *Typhlops braminus*, Daudin, in his garden. They were the first live specimens I had ever seen of this small snake and I was rather surprised to learn that they lived in the burrows of worms in rather hard-packed earth. It was his Chinese gardener who dug up the three specimens we secured that afternoon; all I got for my labours were a lot of blisters! At Tientsin, I visited the Musee Hwang-Ho, Pei-Ho, attached to the French University run by the Jesuit Fathers, and looked through their collection of North China, Manchurian and Mongolian specimens. I found the Museum without any scientific staff; but in the charge of Father Cherquières, who is not a zoologist. He is doing a splendid job of maintaining both the fine collections, and the buildings housing them, in good condition: paying for most of the expenses thus entailed from profits derived from work done on the small printing press in the Museum, as the funds at his disposal are very meagre indeed. A fine example of devotion and self sacrifice in the interests of science as the collections stored at the Musee Hwang-Ho Pei-Ho are most valuable and should not be lost to science. Incidentally, the same applies to the collections at the Musee Heude (which is at Shanghai) that are threatened by damage due to deterioration through lack of sufficient funds to maintain them.

"Could you let me know whether there is any possibility of these Museums receiving a Grant from some Fund in order to maintain the present state of their Zoological Collections which are very comprehensive in several fields? With the present high costs and uncertain economic conditions in China they are finding it increasingly more difficult to carry on."

Werner Schroeder, Direktor des Zoologischen Gartens [Berlin Zoo] Budapester St., 36 (Aquarium), Berlin W 30, Germany, wrote to Frederick H. Stoye under date of February 9, 1947. The letter was long delayed in arrival. Mr. Stoye has kindly furnished the following translation and abstract: "Since over a year I am Director of the Berlin Zoo, which I manage, together with the widow of Dr. Heinroth [the late director]. Drs. Heinroth and inspector Seitz died soon after the end of the war. The Zoo lost the greatest part of its animals and buildings. Our beautiful aquarium was completely destroyed. I have the difficult task of rebuilding and later of managing the aquarium to be.

"At present nothing can be done, as the times are too difficult and many of our people are dying of hunger. In March [presumably March, 1947] the first aquarium and terrarium journal will make its appearance under my editorship. I am anxious to receive, on an exchange basis, similar journals from the United States." [It is assumed that he is also interested in receiving reprints.]

From Dr. C. L. Hubbs comes the following news note : "Dr. F. P. Koumans has resigned his position as Curator of Fishes at the Rijksmuseum van Natuurlijke Historie at Leiden to accept the position as head-curator at the Municipal Hospital at the Hague, where he will be in charge of the Medical-Pharmaceutical library. His future address will be: Medisch-Pharmaceutische Bibliotheek, Gemeente Ziekenhuis, Zuidwal, Den Haag, Holland. Dr. Kouman's place at the Leiden Museum has been taken by Dr. M. Boeseman Dr. Boeseman will appreciate exchange of publications with American ichthyologists."

Word recently received from DR. J. D. F. HARDENBERG, Director of the Laboratorium voor het Onderzoek der Zee at Passar Ikan, in Batavia, Java, tells of the destruction of the war in that region. The laboratory suffered some damage through gunfire, and the machinery of the famous aquarium at Passar Ikan suffered much through neglect. However, the aquarium is again in operation, and many of the tanks now contain fish. Dr. Hardenberg hoped to reopen the aquarium on Christmas. The loss of the fish collection amounted to 50 per cent. Some parts disappeared almost totally, others are more or less intact. The library suffered very severely. However, some of the books were found in other libraries, and other necessary items, such as Bleeker's great monograph, have been borrowed from the laboratory at Buitenzorg. Next year, Hardenberg hopes to have a seagoing boat again. He will then resume his investigations, including those of the fishes of river mouths. His large manuscript on that subject was lost, along with other manuscript material.

American ichthyologists will be delighted to learn that, rumor to the contrary, Honorary Foreign Member LEO S. BERG is well and sound. During the spring Professor Berg was seriously ill with inflammation of the lungs, but according to A. N. SVETOVIDOV, in a letter to WILLIAM GOSLINE, dated November 11, 1947, Dr. Berg was again at his usual work. The first volume of the new edition of Berg's "Fresh-water Fishes of the U.S.S.R." is in print and is scheduled to go on sale early in 1948.

DR. ERNA MOHR, of the Hamburg Zooligisches Museum, writes that the Director of the Museum is PROF. DR. BERTHOLD KLATT, known to herpetologists for his food and form experiments on *Triton*, in connection with his researches on domestication. Dr. Mohr is Curator of the Department of Vertebrates. The Hamburg Museum, its library and collections, was destroyed by fire during the war. Dr. Mohr's home, where a part of her private library and collections is stored, is fortunately intact.

Dr. Mohr announces also that the well known German fisheries biologist, PROF. ERNST EHRENBAUM, died on March 6, 1942. He was, together with HANS LÜBBERT, editor of "Handbuch der Seefischeriei Nordeuropas."

DR. BERTHA LUTZ, of the Museu Nacional, Rio de Janeiro, has been honored by the award of the "King's Medal," by H. M. KING GEORGE VI, in recognition of her service in the cause of freedom.

Our new honorary foreign member, DR. Å VEDEL TANING of Marinbiologisk Laboratorium (Charlottenlund Slot, Denmark), writes appreciatingly of his election, to our society's President. Tåning mentions that the publication of the second part of his experimental study of meristic characters has been delayed, because he recently spent four months on a cruise of the "Dana," investigating the boundary area between the Gulf Stream and boreal waters northeast of the Newfoundland Bank. He discovered here deep-sea fishes of southern origin and thus traced the effects of the Gulf Stream far to the north of previous indications. We will look forward to a report on this work for COPEIA.

DR. M. J. HEUTS has returned to Belgium and is resuming his researches on speciation in sticklebacks. His address is Zoologich Instituut, Universiteit te Leuven, Naamsche Straat 71, Leuven, Belgium.

DR. ROBERT MERTENS writes that the herpetological collection of the Senckenberg Museum is intact in spite of severe damage to the buildings, and adds, "As I never was a national-socialist I am at present working in my old position at Senckenberg Museum and the Frankfort University."

An advertisement from the SEARS FOUNDATION FOR MARINE RESEARCH, Yale University, New Haven, Connecticut, states that the *Journal of Marine Research* presumably will be continued in the form of one volume of three numbers per year. Complete sets of the published five volumes are still available at $15.00 per set.

Dr. Yaichiro Okada has recently sent Dr. Ralph Hile the following list of active Japanese ichthyologists.

Kenzo Ebina: Zoological Institute, Fisheries College, Kurihama, Yokosuka, Kanagawa Prefecture, Japan.

Kinosuke Kimura: Fisheries Experimental Station, Ministry of Agriculture and Forestry, Tsukishima, Tyvô-ku, Tokyo, Japan.

Seiji Kokubo: Marine Biological Station, Tohoku University, Asamushi, Aomori Prefecture, Japan.

Kiyomatsu Matsubara: Fisheries Institute, Faculty of Science, Kyoto University, Maizuru, Kyoto, Japan.

Denzaburo Miyadi: Zoological Institute, Faculty of Science, Kyoto University, Kyoto, Japan.

Muneaki Abe, Jinjiro Nakae, Katsuzo Kuronuma, Hiroshi Nakamura, Yasuo Suehiro: Fisheries Experimental Station, Ministry of Agriculture and Forestry, Tsukishima, Tyuô-ku, Tokyo, Japan.

Nenji Kamohara: Zoological Institute, Kochi High School, Kochi, Kochi Prefecture, Japan.

Yaichiro Okada, Morizumi Nakamura, Masao Watanabe: Research Institute for Natural Resources, Hyakunincho, Yodobashi Shinjiku-ku, Tokyo, Japan.

Hiroaki Aikawa, Keitara Uchida: Fisheries Institute, Faculty of Agriculture, Kyusyu University, Fukuoka, Fukuoka Prefecture, Japan.

Yoshio Hiyama: Fisheries Institute, Faculty of Agriculture, Tokyo University, Tokyo, Japan.

Professor E. K. Surorov, of Leningrad University, writes (to Leo Shapovalov) that an assistant of his, B. F. Shadin, is writing his dissertation on the Balkash perch, *Perca schrenki*. In this connection, he is very anxious to obtain any American literature dealing with the biometry, biology, and ecology of *Perca flavescens*. Professor Surorov's address is: Tchaikovskaya 42, kv. 5, Leningrad 194, U.S.S.R.

Dr. Henry Kritzler has been appointed to the staff of the Marine Biological Laboratory of Marine Studios, Marineland, Florida, as Research Associate. His main field is biochemistry. He received his doctor's degree from the University of Iowa in 1941, and, after war service, served as National Research Fellow in Zoology at the Scripps Institution of Oceanography.

Recent Deaths

We learn with regret of the death of Aden C. Bauman, Chief Aquatic Biologist of the Missouri Conservation Commission. He and a companion were killed in the wreck of a small plane near Fulton, Missouri, on August 27, 1947. Bauman was 36, married, and the father of two sons. His home was in Columbia, Missouri. He was a graduate of the University of Michigan, and joined the Missouri Commission in 1941.

Dr. A. T. Cameron, since 1934 Chairman of the Fisheries Research Board of Canada, died recently.

Miss Grace Eager, well known for her magnificent illustrations of fishes and other animals, for many years the Staff Artist of the University of Michigan Museum of Zoology, died on December 22.

Word is received of the death of Dr. T. D. A. Cockerell at San Diego, California, on January 27. He was a naturalist who worked on many kinds of animals. In the field of ichthyology he is chiefly known for his extensive comparative studies of fish scales.

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